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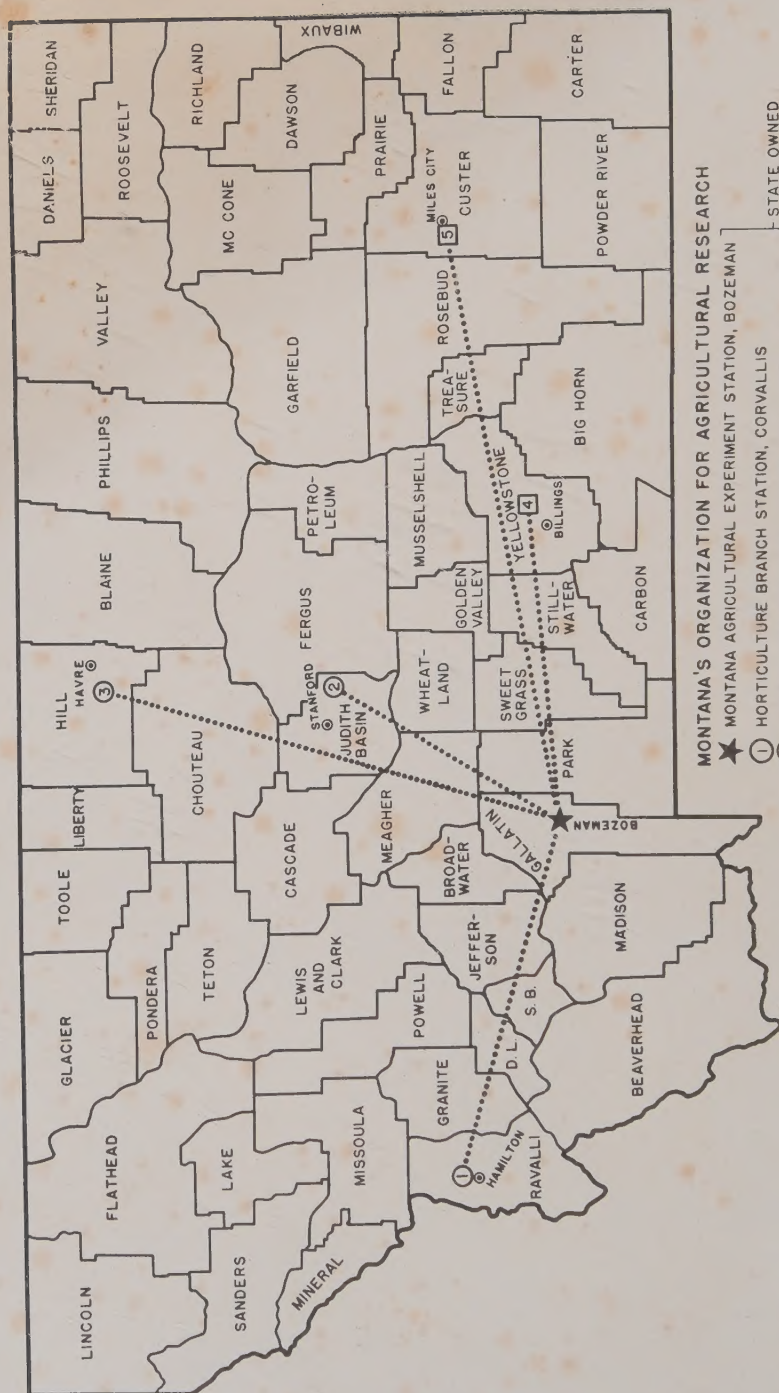
AGRICULTURAL RESEARCH IN WARTIME

Forty-eighth and Forty-ninth
ANNUAL REPORTS
of the

MONTANA AGRICULTURAL EXPERIMENT STATION

July 1, 1940 - June 30, 1942

MONTANA STATE COLLEGE
AGRICULTURAL EXPERIMENT STATION
BOZEMAN, MONTANA



MONTANA'S ORGANIZATION FOR AGRICULTURAL RESEARCH

- ★ MONTANA AGRICULTURAL EXPERIMENT STATION, BOZEMAN
 - ① HORTICULTURE BRANCH STATION, CORVALLIS
 - ② JUDITH BASIN BRANCH STATION, MOCCASIN
 - ③ NORTH MONTANA BRANCH STATION, HAVRE
 - ④ HUNTLEY BRANCH STATION, HUNTLEY
 - ⑤ U. S. RANGE LIVESTOCK EXPERIMENT STATION, MILES CITY
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AGRICULTURAL PROBLEMS DURING WAR

Agriculture occupies a position of commanding importance in the economy of a nation at war. In fact, *agriculture produces the Number One material of modern warfare—food*. The farms and ranches of the United States, now numbering over six million and involving the use of over one billion acres of land, will continue as a dependable source of food because those who operate these “food factories” fully recognize the truth of the statement of Secretary of Agriculture Wickard that “food will win this war and write the peace.”

The democracies which are allied in World War II must win this war. Food is one of the strongest weapons which these democracies may use—it may be the strongest weapon. Even though the United States did not formally enter the war until December 8, 1941, the defense and war preparations of this nation soon made it necessary to ask American farm and ranch operators to meet new challenges—first, the immediate challenge arising from a war-time economy and second, the challenge of preparing to meet the problems of a post-war economy.

American agricultural producers have made notable progress in establishing production goals which will insure adequate supplies of high-quality food for the armed forces of the United States and her allies and at the same time provide adequately for the needs of those who must “keep the home fires burning.”

During periods of national emergency it has been a universal experience that the problems of agriculture have become more complicated and the demand from farmers and ranchers for information to help solve these problems has greatly increased. Already American agriculture is encountering serious “bottle-necks” in its effort to attain the food-production goals of this nation. The requirements for direct defense—materials and equipment for the armed forces—have created some shortages of immediate concern to farmers and ranchers. For example, the producers of agricultural products are already finding it necessary to conduct their operations with a rapidly decreasing supply of farm labor. There will be less iron and steel for the manufacture of farm equipment. Preparation for war means a decreased supply of chemicals for the manufacture of commercial fertilizers and spray materials for the control of insects and diseases. Transportation and storage

problems complicate the handling of agricultural products during the period from production to marketing. The problems of marketing, distributing, processing, exporting, etc., are daily becoming more complicated. The post-war period will present problems for agriculture which will be equally complicated and fully as difficult to solve.

During these periods of national emergency, it is indeed fortunate that the research programs of State Agricultural Experiment Stations are sufficiently flexible that they can meet important current needs for agricultural information and at the same time be readily adapted to meet some of the numerous and rapidly changing problems resulting from such emergencies.

While the research program of the Montana Agricultural Experiment Station has been developed through the years to give primary consideration to the normal agricultural needs and problems of this State, the present national emergency imposes upon each member of the staff the responsibility for examining his work and evaluating the results in terms of service or contributions to Montana farmers and ranchers who again find it necessary to conduct their operations under a war-time economy. Therefore, in preparing the material for the Forty-eighth and Forty-ninth Annual Reports of the Montana Agricultural Experiment Station, an effort has been made by the research departments to point to specific contributions which the investigations and research of this Station are prepared to make to aid Montana farmers and ranchers in meeting some of the agricultural problems which will arise during the trying days ahead.

Agriculture must produce the "food which will win this war and write the peace." Results of agricultural research conducted by the Montana Agricultural Experiment Station and its branches will assist the farmers and ranchers of the State to do their full share of this important task more efficiently.

CLYDE McKEE
DIRECTOR.

VALUE OF AGRICULTURAL RESEARCH IN WARTIME

COMPILED BY

R. T. CLARK, ASSISTANT DIRECTOR

RESEARCH AT THE HOME STATION

DEPARTMENT OF AGRICULTURAL ECONOMICS

By

R. R. Renne

Farmers and ranchers are expected to make important contributions during the war by expanding the production of food-stuffs and agricultural products. However, they are not expected to do this at a loss. It is therefore especially important during this period for farmers to act intelligently in the planning of their farm enterprises so that there will be a satisfactory return on their investment. In many cases those farmers will be patriotic who work out production plans which are most efficient and which will yield them the highest net profit, because usually such practices will be associated with increased production.

FARM COST-OF-PRODUCTION STUDIES

The Agricultural Economics Department has gathered data showing the costs of producing various farm and ranch products under Montana conditions and the important factors which contribute to successful operation and low unit costs of output. Farmers can use such information as yardsticks or standards to determine their relative efficiency and the corresponding profitableness of their operations. These data are particularly useful to farmers and ranchers in determining purchase prices, lease rates, borrowed funds, taxes, and related costs that they can reasonably afford to assume. In such products as milk, where a state control board sets prices, reliable cost-of-production data are very useful to farmers in making their claims for just prices to be set in market areas under the control of such a price board. Similar cost-of-production data are extremely useful in arriving at reasonable producer prices

set by governmental agencies for various products whose expanded production is desired during the war period. Of very great value, however, is the specific use which can be made of such cost-of-production data and efficiency indexes by each individual farm and ranch operator. These data are of particular importance during the war when it is absolutely essential to get the maximum production with a given expenditure of labor.

COST-OF-MARKETING STUDIES

Along with cost-of-production studies, research which makes available cost-of-marketing information for farmers and ranchers is especially useful during a war period. Such cost-of-marketing studies set up efficiency standards or yardsticks and point out factors essential for most efficient marketing methods and organization. The Agricultural Economics Department has made studies of the cost of distributing milk and the factors which are most important in determining unit costs of milk distribution. Such studies are particularly timely in view of rubber shortages and labor scarcities. Producer-distributors and distributors can utilize such cost-of-marketing information to assist them in determining the types of improvements which they can make to reduce their costs and meet existing problems. Cost-of-marketing studies not only reveal the data essential for farmers and ranchers to secure distinct savings but also methods which will result in economic and social benefits for consumers as well as producers.

LAND-UTILIZATION STUDIES

One of the most important types of information which is now available from studies made by the Department of Agricultural Economics is that which attempts to set up the cropping and utilization practices which are best adapted for various types of land. Studies have been made which point out the conditions under which collective tenure such as Soil Conservation Districts and grazing districts can be most useful. Such information as the problems of organization, operation, allocation of rights, and conservation practices will enable farmers and ranchers to have more stable and satisfactory operations. Such specific suggestions as the desirability of farmers' and ranchers' securing written leases for the duration of the war and including provisions which will give such tenants compensation for capital outlays and improvements required in the war-expansion program have grown out of these studies. The suggestion has been made that clearing houses be established in each county to pass upon land transfers as a means of retaining lands in their most adapted uses and most efficient operating units.

Specific recommendations which have grown out of land-economics studies of the Department of Agricultural Economics with regard to credit include suggestions for immediate steps (1) to control land values and further the war effort through encouraging public and private credit agencies to base appraisals and loans on average prices and production, (2) to devise methods for variable payments on loan agreements, thus contributing to setting aside reserves during current periods of high farm prices, and (3) to use credit to channel land into uses most conducive to attainment of war goals, and to make every effort to prevent speculation on the basis of current prices and demand for land.

Specific recommendations growing out of land-economics studies of the Agricultural Economics Department regarding taxation include (1) suggestions to encourage counties to establish a more flexible policy of taxation to avoid high and low revenue periods, and (2) land-classification procedures which will enable local assessors to determine the true productive value of farm and ranch lands for assessment purposes.

FARM TAXATION AND CREDIT STUDIES

The Department of Agricultural Economics has made careful studies of the relative tax load carried by various groups. This type of information is of particular value to farm and ranch leaders who have a part in determining what taxes will be levied and the amount of such levies. During a rising price period such as the current war years such information is of particular importance if inflationary tendencies are to be reduced to a minimum and the war effort is not to bog down hopelessly.

The department has gathered together a large amount of information showing the costs of credit to farmers and ranchers under various methods and types of borrowing, and the factors which are responsible for unsatisfactory farm and ranch loan experience (bankruptcies and foreclosures). This information is fundamental to the establishment of sound lending and borrowing practices and is being used increasingly by farm-lending agencies and by the more alert farmers and ranchers of the state. During this period of rising land values such credit information is particularly useful.

RURAL SOCIOLOGY STUDIES

A very important type of information made available to farmers and ranchers and to those responsible for certain agricultural programs is the amount and kind of labor needed in certain areas for agricultural production. The Department of Agricultural Economics has made a very careful survey of the need for beet labor in the state and the possible source of labor supply and prospective deficiencies. This information has been turned over to the State

Agricultural Labor Committee and the State Agricultural Labor Reporting Service. Further studies are now being made in selected areas to determine the available labor supply for agricultural employment.

Another type of information which is just becoming available from studies by this department is that which delimits community boundaries within counties. The delimitation of community boundaries is of particular usefulness for community planning committees of farmers and ranchers in creating effective rural organizations to study and determine war production goals for each community, to establish community contacts for labor recruiting and supply, and to serve as a clearing house for numerous war and post-war planning and adjustment problems.

OTHER STUDIES AND SERVICES PARTICULARLY USEFUL TO FARMERS AND RANCHERS IN WAR TIME

Numerous other types of information of particular usefulness to farmers and ranchers are available. One type is the classification of irrigable and potentially irrigable land resources available for settlement by stranded farm families and for use by existing operators to round out a more adequate operating unit. Analysis of enterprise organization on successful irrigated farms in various areas furnishes the basic information for prospective settlers to determine the size of units, water charges which can be paid and related information for new irrigation areas.

The collection of data showing sales of new power machinery gives a comprehensive view of total power machinery sales each year and is helpful in determining the available machinery in the state for use during the present emergency. Studies of the characteristics and problems of low income farm and ranch families are of special value in providing the basis for a general social improvement program for raising the levels of living and production of this large low income group.

If expanded and sustained production is to be achieved, farmers and ranchers themselves, as well as their county extension agents and leaders, must have the information showing the present conditions under which farmers operate. If farmers are to increase their production in connection with the war effort, they must know what conditions need to be changed to enable them to produce this increased output profitably.

DEPARTMENT OF AGRONOMY

By

A. H. Post

The research conducted by the Agronomy Department may be divided into several different lines of work that have a direct or

indirect bearing on the Food for War Program that is being sponsored by the Government. The research program has been built up over a period of many years for the purpose of supplying information on the production of crops to farmers and other interested parties in Montana. The problems receiving attention at the present time are (1) the classification and use of soils in Montana, (2) the maintenance of soil productivity, (3) crop adaptation, (4) the breeding, selection and development of new and improved varieties of farm crops, (5) the improvement and utilization of grasses, (6) the control and eradication of noxious perennial weeds and (7) soil and water conservation.

THE CLASSIFICATION AND USE OF SOILS IN MONTANA

To produce the necessary farm products for war, without sacrificing our present land-use program, and at the same time be prepared for post-war changes is a tremendous task that will require the cooperation of all agricultural agencies. The direct responsibility for such a program probably rests with land-use or planning committees. These committees and other agencies require fundamental information about the soils of their respective counties and state as a basis for sound land-use planning. The soil survey is primarily an inventory of the soil resources of an area, county or state. As conducted in Montana it furnishes this type of information: it determines the location and extent of various soil types and their relative value for crop production or range utilization. This information is being published in report form and includes the following material:

A. Soil maps that show the location and extent of the different kinds or types of soil. The individual soil types are fully described giving their depth, texture, reaction (acid or alkali), tilth, erodibility, surface and internal drainage, topography, crop adaptations and recommended management practices.

B. Land classification maps are generally included. They classify the various soil types according to productivity for dryland or irrigation farming or grazing purposes.

Reconnaissance or general soil surveys have been completed for twenty-eight counties in Montana. Reports have been published for nineteen of these counties and maps prepared for nine. Partial reconnaissance surveys have been conducted for nine counties. Detailed soil surveys have been conducted in eleven irrigated valleys of the state. Reports have been prepared and published for nine of the areas surveyed.

Properly used soil survey information can be helpful in securing the necessary war-time crop production without plowing up additional range or abandoned crop land.

THE MAINTENANCE OF SOIL PRODUCTIVITY

The problem of maintaining the productivity of soils has a direct bearing on crop production in war-time. Such a practice is considered necessary under any conditions, but especially so when the world is engaged in a total war. Research on the value of crop rotations and the use of farm manures and commercial fertilizers is especially important at this time. If it is necessary to produce more food and fibre crops because of the war, it is essential that every effort be made to do so on the land now in cultivation rather than to break up marginal land as was done during the first world war. To make this possible the land now being cultivated must be fertilized and properly managed to increase the *per acre* production.

On irrigated land in Montana this increased per acre production may be obtained by the adoption of a good crop rotation and the use of farm manures and commercial fertilizers. As a result of rotation experiments conducted at the Montana Agricultural Experiment Station for the past fifteen years, it is possible to draw the following conclusions:

1. Maximum or high yields of cereal grains and potatoes are possible only when grown in a good rotation which includes a leguminous crop such as alfalfa.

2. The addition of farm manure to the crop rotation has been responsible for increased yields of all crops in the rotation.

3. The use of commercial fertilizers for the production of spring wheat continuously cropped has been less effective than where spring wheat followed three years of alfalfa in a six-year rotation. A combination of manure and phosphate fertilizer or nitrogen and phosphate gave the best results for spring wheat on the continuously cropped plots.

In addition to the rotation experiments the department is testing various commercial fertilizers in different parts of the state to determine their effect on the yield and quality of crops. The results to date have shown that many irrigated and non-irrigated soils in Montana are deficient in phosphorus and nitrogen. Experiments conducted on some of these soils have shown that it is often possible by the addition of a phosphate or a phosphate and nitrogen fertilizer to increase the yields of cereal grains, sugar beets and alfalfa 10 to nearly 100 per cent. The results obtained from some of these experiments in 1941 are presented in table 1.

It is not to be implied that similar results can be obtained on all soils in Montana. However, in most areas where sugar beets are produced, the use of barnyard manure and/or phosphate fertilizer is

recommended for maximum per acre yields. No doubt the present acreage of sugar beets could be made to produce 10 to 25 per cent more beets than is now being produced, by the use of liberal applications of barnyard manure and phosphate fertilizer together with good soil management.

If it is desirable to increase the production of winter wheat, it appears from the results given in table 1 that small applications of phosphate fertilizer would be helpful. In other words the data presented show that if the farm operators in Montana are required to increase crop production as a war measure, it is possible to do so without putting additional and probably low-grade land under cultivation.

TABLE 1. THE EFFECT OF FERTILIZERS ON THE YIELDS OF WINTER WHEAT, SUGAR BEETS AND ALFALFA IN VARIOUS PARTS OF MONTANA IN 1941

Crop and location of Experiment	Kind and amount of Fertilizer	Yield per acre	Per cent of check
Winter Wheat			
Cascade County (dry land)			
	Check—no fertilizer	27.8 bu.	—
	Treble superphosphate—25 lbs.	36.8 bu.	132.5
Judith Basin Branch Exp. Sta. (dry land)			
	Check—no fertilizer	47.4 bu.	—
	Ammoniated phosphate (6-30) 75 lbs.	58.8 bu.	124.1
	Treble superphosphate—25 lbs.	55.8 bu.	117.7
Gallatin County (irrigated land)			
	Check—no fertilizer	29.2 bu.	—
	Treble superphosphate—100 lbs.	56.7 bu.	194.3
Sugar Beets (irrigated land)			
Ravalli County			
	Check—no fertilizer	22.4 tons	—
	Complete fertilizer—250 lbs.	26.6 tons	118.6
Cascade County			
	Check—no fertilizer	8.5 tons	—
	Complete fertilizer—250 lbs.	12.1 tons	143.4
	Treble superphosphate—100 lbs. & ammonium sulfate—100 lbs.	10.6 tons	124.8
Yellowstone County			
	Check—no fertilizer	10.4 tons	—
	Treble superphosphate—100 lbs.	14.7 tons	141.2
	Treble superphosphate—100 lbs. Ammonium sulfate—100 lbs.	16.5 tons	158.5
	Boron—20 lbs.		
	Complete fertilizer—250 lbs.	14.8 tons	142.4
Alfalfa (2nd cutting—irrigated)			
Teton County			
	Check—no fertilizer	1.39 tons	—
	Treble superphosphate—100 lbs.	1.88 tons	135.2
	Treble superphosphate—200 lbs.	1.99 tons	143.2

CROP ADAPTATION

One of the main functions of the Agronomy Department is to test hundreds of crop varieties each year for the purpose of determining their adaptation to Montana soil and climatic conditions. This is especially true for such crops as wheat, oats, barley, rye, flax, soybeans, alfalfa, and corn. Many of our recommended varieties of cereal crops such as Marquis and Ceres spring wheat, Trebi barley and Victory oats, have been the results of such tests. Each year new varieties of different crops appear in neighboring states and ultimately get to Montana. The logical agency to determine the adaptability of these new crops is the Experiment Station. Data are available regarding the yields and reaction of most varieties of cereal grains in Montana and neighboring states. It is necessary to continue this type of research to prevent the sale of inferior varieties of crops in Montana. This work is a continuous process because there are new varieties appearing each year. Since inferior cereal crop varieties usually mean lower yields, it is important that only tested and approved varieties be grown.

THE BREEDING, SELECTION AND DEVELOPMENT OF NEW AND IMPROVED VARIETIES OF FARM CROPS

This phase of agronomy research includes the production of new varieties and the selection of superior introduced varieties of wheat, flax, oats, barley and leguminous crops.

In the wheat improvement program approximately 3,000 different selections are being tested. These selections are from crosses made to combine greater winter hardiness and smut resistance with high quality in the case of winter wheats and with spring wheats the crosses were made to combine good breadmaking qualities with resistance to bunt smut, leaf and stem rust as well as high yields and resistance to drought.

As a result of the wheat breeding program Thatcher and Pilot spring wheats have been recommended for northeastern Montana where black stem rust has caused heavy losses. These varieties are resistant to black stem rust and have excellent quality for breadmaking. Onas, a white spring wheat which produces more grain per acre for feed in the intermountain irrigated valleys than any other wheat variety, has been developed and distributed in the area mentioned. A selection of a cross of Ridit x Utah Kanred winter wheat was introduced from Utah and found to be resistant to a peculiar type of stinking smut which is especially destructive to winter wheat in the Gallatin and Flathead valleys. This smut cannot be controlled by seed treatment.

The barley improvement program in Montana includes the testing of approximately 250 distinct varieties or selections in various stages of development in field plot and nursery trials. As a result of the barley improvement program, a new drought-resistant

and high-yielding variety named Compana has been distributed for production on dry land. The general acceptance of this new variety for production on dry land may increase barley yields per acre as much as 10 to 30 per cent. Other new selections being tested in field plots appear to be even superior in yield to Compana, but require further study before their distribution is recommended to farmers of the state.

The breeding work with oats, an important feed grain in Montana, includes the study of some 123 different varieties or selections in field plots and nursery trials. The purpose of this work is to find superior yielding varieties for both irrigated and non-irrigated land in Montana. When a new variety has been thoroughly tested and found to be superior to existing varieties it is recommended for distribution in the state. Bridger, a new variety of oats resulting from this work, was named and recommended by the Agronomy Department in 1941. Bridger is similar to Victory in yield and in plant and grain characteristics but is much more resistant to lodging. In addition, it is resistant to most physiologic races of smut to which Victory is susceptible. This new variety of oats has been approved by the Montana Seed Growers Association and is being distributed in 1942.

Approximately 250 different varieties or selections of flax were included in the flax improvement nursery in 1941 and 1942. Flax improvement work has been increased in recent years especially as related to seed production. The war has made it necessary for the United States to increase the production of flax seed and also fibre flax. Experimental data indicate that fibre flax could be produced satisfactorily on irrigated land in Montana. However, all fibre processing plants are located at great distances from Montana which would probably make the production of fibre flax questionable. Cirrus, the leading flax variety for fibre production, produces a height of 42 inches at Bozeman.

The research work reviewed is part of a crop improvement and development program that must continue over a period of years to be effective. It has a direct bearing on the per acre production of crops produced in Montana. Many of the crops being studied, such as barley, oats and leguminous crops, are important as feed for livestock. The increased war demand for livestock and livestock products means there is a need for increased yields of feed grains and forage crops. This can be brought about by growing only high-yielding and approved varieties.

THE IMPROVEMENT AND UTILIZATION OF GRASSES

The war-time production needs of this country have re-emphasized the importance of maximum forage production on range and cultivated lands of Montana. To accomplish this, three major problems are being considered in the research work with grasses

which are as follows:

1. Finding the best adapted grass species or combination of species to regrass the dry-land areas of the state where the native vegetation has been destroyed.
2. Combining new or improved grass species for use on the pastures of intensively farmed lands.
3. Determining the value of different grass species by livestock utilization studies.

Since 1936, over 70 species and 5,000 selections of grass which might be suited for Montana have been tested at the Agricultural Experiment Station. Crested wheatgrass continues to be the best single species for regrassing abandoned farm lands. Crested wheatgrass is desirable for seed and forage production, hardiness and ability to compete with weeds, but it lacks heat tolerance. For this reason improvement work on two heat-tolerant grass species is being emphasized. Seeded in mixtures, these heat-tolerant grasses should supply some forage during the hot seasons when crested wheatgrass is more or less dormant.

Of the many grass species tested it appears that three or four may in time prove valuable for the better lands of the state. A new species called "Alta" fescue (*Festuca elatior* var. *arundinacea*) has demonstrated some highly desirable characteristics in recent experimental work at Fort Ellis. Sheep were allowed to graze a two acre plot of Alta fescue from late April to June first. The plot was then protected and allowed to produce a seed crop. It was cut for seed in late August and produced 555 pounds of clean seed per acre. By November 10, when most of the other grass species in the test were dormant, a frost resistant regrowth of Alta fescue was thick and one foot high. If this grass will thrive in other sections of the state, its ability to produce green feed in early spring and late fall will be a definite contribution to the livestock industry.

The grass research program in Montana has reached the stage where livestock utilization studies on the most promising species seem justified. Until a species has been subjected to either range or pasture conditions, it is difficult to determine its true value. The Judith Basin Branch Station grazing experiments showed total gains in animal weight per acre of 70.2, 32.5, and 45.5 pounds respectively, on the crested wheatgrass, native grass and brome grass. To obtain similar data for 15 different species of grass, an extensive utilization study using sheep was begun in 1942. The results of this work have not been completed.

THE CONTROL OF PERENNIAL WEEDS

The farm operators of Montana realize that perennial noxious weeds have become a serious problem and that these weeds are responsible for decreasing crop yields, increasing cost of production, and lowering land values. In time of war when maximum crop

production is being requested, the war against weeds should not be laid aside. Rather, it should be continued as a part of the larger program of maximum crop production.

Weed control research has been increased recently by the Montana Experiment Station to include local work and cooperation with certain counties through their extension agents.

In addition to chemical treatments some tillage work was done with white top. In 1942 additional work was done on tillage, competitive crops and burning. The research program with tillage and burning has been increased for the purpose of furnishing correct procedures to follow. In regard to burning or searing, an attempt is being made to determine the best kind of oil to use, the necessary pressure required, the degree of burning necessary for each operation and the number of burnings necessary to effect eradication.

SOIL AND WATER CONSERVATION

A new research project on soil and water conservation was begun in 1941 at the North Montana Branch Station. This project was begun for the purpose of determining desirable tillage practices and the best means of handling crop residues for soil and water conservation. There are three distinct methods of handling crop residue being studied in this project. These methods are (1) leaving residues on the surface of the ground, (2) incorporating residues with the surface soil and (3) turning the residues completely under.

Similar work has been under way near Froid, Montana since 1940. These projects are to be continued for at least five years. It is the purpose of this research work to find suitable methods of preparing fallow land to prevent erosion by wind and water and at the same time conserve moisture and thus produce maximum yields of cereal grains. The results of this work may be of great benefit to the farmers in the state in the post-war period. This will be especially true if governmental pressure or high prices causes the plowing up of light and erodible soils.

DEPARTMENT OF ANIMAL INDUSTRY AND RANGE MANAGEMENT

By

R. T. Clark

The research program of the Department of Animal Industry and Range Management is based on production problems. For that reason this department actually produces animal products in sizable amounts and therefore makes a direct contribution to the "Food for War" effort.

After all research information had been secured, the following items were marketed throughout the business year, July 1, 1941 to

June 30, 1942: 59,000 pounds of cattle, 99,000 pounds of lambs, 50,000 pounds of hogs and 22,000 pounds of wool. In keeping with the agricultural war production program, it is the intention of the department to maintain this production insofar as this can be accomplished with decreased personnel.

BEEF CATTLE RESEARCH

In connection with Record of Performance testing of Hereford cattle, two rations were evaluated. Results indicated that when a basic ration of 45 per cent ground barley, 45 per cent dried molasses beet pulp, 10 per cent linseed meal, and chopped alfalfa hay was fed to steer calves, they gained significantly faster than a comparable group of calves fed 50 per cent ground barley, 50 per cent dried molasses beet pulp, and chopped alfalfa hay.

Performance testing of beef cattle is being conducted in cooperation with the North Montana Branch Station and the Bureau of Animal Industry, U. S. Department of Agriculture. Uniform conditions of treatment are applied to all cattle in order that observed differences can be attributed to the breeding ability of the particular animals being appraised. Among various sire groups the following differences have been observed:

- (1) Total feed cost per steer, \$37 to \$52.
- (2) Cost of feed per 100 pounds gain, \$8 to \$10.
- (3) Sales value per steer, \$93 to \$122.
- (4) Return per steer, \$48 to \$62 (labor charges not deducted).

These data indicate that the variability between certain lines of breeding is of sufficient economic magnitude to warrant intensive investigation.

Aside from fattening work with Hereford steers of known ancestry, tests of heifers of similar breeding are being made. This work stresses the maintenance requirements of known progeny groups. Results to date indicate that the "easy keeping" qualities of specific animals are inherited and that certain heifers will gain more than others where all animals are provided the same feed above maintenance.

WOOL SHRINKAGE

In cooperation with the Agricultural Marketing Administration, U. S. Department of Agriculture, investigations in the field of wool shrinkage revealed the following facts:

- (1) The methods of sampling employed in the field are accurate and truly reflect the bulk shrinkage.
- (2) 100,000 pounds of wool from representative producing areas throughout Montana were scoured. The average observed

shrinkages were as follows: fine 56.8 per cent; $\frac{1}{2}$ blood, 56.5 per cent; and $\frac{3}{8}$ blood, 51.9 per cent.

(3) All wools tested under this program shrank considerably less than the figure of 64 per cent, commonly ascribed to Montana wools. The importance of this fact is recognized by wool producers themselves. Several have testified that research information on their individual clips has resulted in higher values received. The quality and light shrinkage of Montana wools is now recognized by the wool trade.

(4) The average clean yield of wool per sheep varies from 3 to 6 pounds.

(5) Within an experimental band of fine wool sheep maintained under uniform conditions, the average grease fleece weight varied from 9 to 11.7 pounds, whereas the average clean yield per sheep only varied from 4.3 to 4.8 pounds through the four-year period covered by this study.

SHEEP BREEDING

Intensive breeding studies are being made under strictly range conditions on five families of Rambouillet sheep. These represent specific bloodlines within this breed. Distinct differences in growth rates, clean yield of wool, fleshing qualities and amount of face covering have been noted. The assistance of several outstanding breeders within the state has been greatly appreciated in furthering this work.

A study is being made to test the inheritance of wool and lamb production in Columbia sheep under range conditions. The following economic characteristics are being stressed through selection and breeding: (1) early maturity, (2) fleshing qualities, (3) $\frac{3}{8}$ blood grade of wool, (4) length of staple, and (5) fleece density.

A four-year summary of crossbreeding for the production of milk-fat lambs from high mountain ranges has been completed. Each year Suffolk, Hampshire, Columbia, Corriedale and Romney rams have been bred to grade Rambouillet ewes, producing a total of 2587 lambs. Important results obtained to date are as follows:

(1) The Suffolk cross produced the most fat lambs.

(2) The Suffolk cross produced higher quality carcasses.

(3) The Hampshire and Columbia crosses produced approximately the same number of fat lambs and similar quality carcasses.

(4) The Suffolk cross lambs made the greatest daily gains.

(5) The Corriedale and Romney crosses produced fewer fat lambs and the average lamb weights were lower than that of the other crosses.

(6) The Corriedale and Romney crosses included the most twins of any of the groups.

RANGE AND NUTRITION RESEARCH

Methods of obtaining full utilization of grazing lands by range sheep without deterioration of the forage, and the building up of depleted range lands to greater carrying capacities have been observed over a period of years. Use of the tepee system (one night bed ground) of herding has been practiced rather than the use of permanent bed grounds. Improved forage production adjacent to formerly permanent bed grounds has resulted.

Deferred and rotational grazing of greatly overgrazed areas has permitted seasonal reseeding to take place. Such areas now have a very noticeable stand of native vegetation with greater carrying capacities.

Digestion studies on certain grasses, using sheep as the experimental animals, have revealed that, on the basis of total digestible nutrients at anther falling stage, the following grasses can be ranked in descending order; slender wheatgrass, mountain brome, Fairway crested wheatgrass, Standard crested wheatgrass, and smooth brome grass.

The Department of Animal Industry is cooperating with the Judith Basin Branch Station, Moccasin, in appraising crested wheatgrass pastures and various types of crested wheatgrass hays to determine their relative values as winter roughages for beef cattle. Results to date indicate that steer calves and long yearlings can be developed into fleshy feeders on such feeds, provided small amounts of suitable protein supplement are also fed.

Considerable work has been completed by this department in testing home-grown feeds for fattening lambs. Rations with and without beet by-products have been studied. The most suitable combinations of feeds and methods of feeding were also taken into consideration. Various protein and mineral supplements have been included in the rations tested. Some of the results are as follows:

- (1) In a comparison of various small grains fed with wet pulp and alfalfa, oats have proved superior in producing the heaviest gains at the least cost per hundred pounds of gain. The other grains tested were hard and soft wheat, barley and corn.
- (2) Corn produced the second heaviest gains, but at the highest cost per hundred pounds of gain.
- (3) Soft and hard wheat were of almost equal value.
- (4) Barley produced the lowest average daily gain.
- (5) Self-feeding proved to be more economical than hand-feeding.

DEPARTMENT OF BOTANY AND BACTERIOLOGY

By

H. E. Morris

BUNT OF WHEAT

Bunt or stinking smut of wheat is considered the most serious disease of wheat not only in Montana but in all the wheat producing areas of the world.

Montana produced 68,239,000 bushels of wheat in 1941, consisting of 27,762,000 bushels of winter wheat and 40,477,000 bushels of spring wheat. Largely because of decreased yields and bunt dockage due to the bunt disease the annual loss in the state frequently comes to \$750,000 or more, which amounts to approximately 1½ per cent of the money value of the 1941 crop.

The loss by bunt can be practically eliminated in spring wheat, and materially reduced in winter wheat by adopting the recommended control measures advocated by the Botany and Bacteriology Department.

These control measures are based upon a detailed knowledge of the causal organisms, their life history and the results of numerous tests with various fungicides, and briefly stated are as follows:

1. **ELITE SEED.**— If seed, free or nearly free of bunt, is planted, much less bunt will occur in the resulting crop.

2. **RESISTANT VARIETIES.**— Losses from bunt may be greatly reduced by growing resistant varieties adapted for the particular locality. In choosing a variety secure all available information regarding resistance to diseases, adaptability, commercial qualities, yielding properties, etc., from the Montana Agricultural Experiment Station, Bozeman, Montana.

3. **SOIL CULTURAL METHODS.**— Certain farm practices are important factors in controlling bunt. A soil temperature of about 10°C. (50°F.) and a moisture content around the optimum for plant growth is favorable for bunt. Many results indicate that from September 10 to 20 is the most favorable time to plant winter wheat in Montana to control bunt, as the soil temperature is generally favorable for the growth of wheat and unfavorable for bunt development at this time.

4. **SEED TREATMENT.**— Seed treatment of all wheat seed is good insurance every year. A very important factor in seed treatment is thorough application of the chemical. The machine used for applying dust, either home made or factory built, should be of a satisfactory type and of sufficient capacity.

Copper Carbonate.—Use 2 ounces of 50 per cent copper carbonate to each bushel of wheat or 3 to 4 ounces of the 18 to 20 per cent copper carbonate. The stronger product is preferable for winter wheat. Treated grain may be stored for a year or more. Always be sure the drill shaft is loose, before starting to drill, especially if treated grain has been allowed to remain in the drill for several hours or longer.

New Improved Ceresan.—Use $\frac{1}{2}$ ounce to each bushel of wheat. Apply New Improved Ceresan in a mixing machine, and allow the treated grain to remain in sacks at least 24 hours before being sown.

(Caution.—Wheat treated with copper carbonate or New Improved Ceresan, on account of their poisonous properties, should never be used as human feed or as feed for livestock).

OAT SMUTS

The 1942 goal for oats in Montana is 500,000 acres, an increase of 75,000 acres over the 1941 acreage. This increase in acreage would be almost nullified if no measures are taken to control oat smuts. For many years the loss from oat smuts in Montana has been approximately 10 per cent, due largely, if not entirely, to lack of seed treatment. Oat smuts can be eliminated for all practical purposes by treating the seed with New Improved Ceresan— $\frac{1}{2}$ ounce to 1 bushel of seed in a rotary type treating machine, or by using formaldehyde in solution or in the dust form. Formaldehyde dusts are usually applied at the rate of about 3 ounces per bushel. Formaldehyde in solution should be used at the rate of 1 pint of formaldehyde to 1 pint of water. Apply this mixture uniformly as a fine spray at the rate of 1 quart to 50 bushels of oats as it is being shoveled from one pile to another on a clean floor. Cover the pile for 4-8 hours with canvas or sacks which have been disinfected. Sow immediately or aerate thoroughly before storing the treated grain. Do not treat more seed than is necessary as treated seed is not fit for human food or feed for livestock.

GREAT NORTHERN BEAN IMPROVEMENT PROGRAM

In the early period of growing Great Northern beans in Montana the mosaic disease caused an annual estimated loss of from 6 to 8 per cent of the crop. The control of this disease was the major disease problem in the bean production area.

This problem has been studied by the Botany and Bacteriology Department from two angles, (1) the use of certified seed, (2) the selection of individual plants from within the stock growing in the state—in the hope of securing plants showing resistance to mosaic and having the desired qualities of a marketable bean.

The use of certified seed, i. e., seed containing a low percentage of the mosaic disease, served an immediate useful purpose as this good seed produced higher yields. This method was practiced until the introduction of some Idaho selections of the Great Northern bean, which were immune to mosaic. These better selections have practically replaced the former "field-run" stock of seed.

In the selection of individual plants for freedom of disease, and desirable marketable qualities considerable progress has been accomplished. Several selections have remained free of mosaic for several years, and in plot yield tests at the Huntley Experiment Station they have produced greater yields than the Idaho selections.

An intensive test regarding their productiveness will be made during 1942 and, providing satisfactory results are obtained, some seed of these better selections will be released for the 1943 crop.

DISEASES OF SUGAR BEETS

About 67,000 acres of Montana's fertile irrigated land were devoted to the production of sugar beets in 1941. Montana ranked third in the production of sugar beets in 1940, and fifth in 1941.

Growers realize the major part of their income from the sale of beets, but the tops used as livestock feed mean additional money to the producer. In recent years a very substantial livestock feed-er program has been developed in the sugar beet districts.

If the sugar beet yields are to be maintained precautionary measures must be taken to prevent seedling and deficiency diseases of the sugar beets. The Botany and Bacteriology Department, in cooperation with the Chemistry Department, began an investigation of these diseases in 1934, the results of which are discussed.

I. SEEDLING DISEASES OR "BLACK ROT" OF SUGAR BEETS

Seedling diseases have considerable importance in growing sugar beets, especially on the heavy irrigated soils in Montana. In investigations on the nature and control of these diseases the effect of seed treatments, soil treatments, proper or balanced fertilization, preceding crops to sugar beets, temperature and moisture were studied relative to the occurrence and control of seedling diseases. The results obtained under all these studies are summarized in the following statements.

1. Seed treatments were found to be only slightly beneficial in controlling seedling diseases of sugar beets.

2. Soil treatments or fertilizers were found to be of *great* importance in the control of seedling diseases. Sugar beets planted on plots well fertilized with manure in the fall and supplemented in the spring with nitrogen and phosphate in the form of artificial fertilizers always had only small, insignificant

amounts of seedling diseases as compared to a great per cent of diseased seedlings in soil poor in nutrients.

These results show that furnishing readily available plant food to young sugar beets when they are becoming established and their food absorbing root system is small, appears to be a significant factor in making the plants more resistant to the invasion by soil or seed-borne pathogens. Proper and complete soil fertilization may also affect the virulence of the organism or organisms causing the root rots of sugar beets.

Improvement of the physical conditions of heavy irrigated soils also has its importance in the control of seedling diseases of sugar beets. Soils with a good physical structure have better aeration and drainage than those with a poor physical structure.

3. Proper or balanced fertilization is important not only in controlling seedling diseases of sugar beets, but also in obtaining the maximum possible yield under given environmental conditions. Experiments conducted with different ratios of phosphate and nitrogenous fertilizers showed that the lowest amount of seedling diseases and the heaviest and largest seedlings were produced where 1 part of treble superphosphate and 6 parts of calcium nitrate or 4 parts of ammonium sulphate were added to the soil. It is not intended to recommend these treatments for all soils as the proportions of these fertilizers applied to different soils undoubtedly will vary. In this study it was also found that when calcium nitrate and treble superphosphate were applied, the amount of seedling diseases was less than when ammonium sulphate and treble superphosphate were used. As the sugar beets are so dependent on nitrates, it is not difficult to explain the differences in the amount of seedlings diseases with calcium nitrate as compared with ammonium sulphate. Nutrition of young sugar beets is very localized and is dependent on easily available nutrients. Time and certain favorable environmental conditions are necessary before nitrogen, applied in the form of ammonium salts, becomes available to sugar beets. This period may be quite critical in making plants more or less resistant or susceptible to seedling diseases. All these studies show that to produce a good yield of healthy beets the fertilization of soil should be based on an intelligent knowledge of a crop and its soil requirements regarding nutrients.

4. It is a well-known fact that preceding crops exert their influence on the crops which follow them. The effect of several preceding crops on the amount of seedling diseases of beets in heavy irrigated soils of Montana was investigated. It was found that the lowest amount of beet seedling diseases occurred when the beets were planted after corn. Seedling diseases of beets occurred in increasing amounts when they were planted after corn, potatoes, oats, alfalfa, beans, beets and check (continuous fall-

low). This study is in continuation now, to explain such a pronounced effect of different preceding crops on the amount of seedling diseases of sugar beets which follow them.

5. It is a well-known fact that environment has a great influence on the occurrence and development of many plant diseases, and particularly it has a great effect on the amount of seedling diseases of sugar beets. To obtain definite information on this subject, investigations were conducted in which the effect of temperature and moisture on the amount of seedling diseases of beets was studied in heavy irrigated soils under controlled conditions. This problem was studied at five different temperatures: 10°C. (50°F.), 15°C. (59°F.), 20°C. (68°F.), 25°C. (77°F.) and 30°C. (86°F.), and three different soil moistures: maximum (85 per cent of saturation), optimum (75 per cent of saturation) and minimum (50 per cent saturation).

The results of this study show that low temperatures (10°C. or 50°F.) and a minimum of moisture are more favorable to sugar beets from the standpoint of freedom from seedling diseases than high temperatures. Even at the maximum and optimum of moisture, seedling diseases were relatively small at low temperatures, and increased considerably with high temperatures. The results support the necessity of early planting of sugar beets when temperatures are still low, to avoid a high amount of seedling diseases which may appear at higher temperatures.

II. PHOSPHATE AND NITROGEN DEFICIENCIES IN SOILS AND THEIR EFFECTS ON SUGAR BEETS

Sugar beets require a considerable amount of readily available phosphorus and nitrogen for their full development. Many of the beet fields in irrigated valleys in Montana do not yield well because there is a shortage of one or both of these plant nutrients.

Phosphate deficiency varies in its intensity in different soils and for different crops. A slight deficiency of available phosphate may not produce symptoms in sugar beets that are readily recognized, although the beet roots are small, the tonnage low, and the tops remain green up to harvest. Under such conditions the ratio of tops to roots is higher than where there is sufficient phosphate. In case of a severe phosphate deficiency in the soil, necrotic spots will appear either on the edges of the sugar beet leaves or between the veins in July or later. These spots enlarge and their color changes from light to dark brown and finally to black. In severe cases many spots coalesce and finally the whole leaf blade begins to have the appearance of being burned and the leaves assume the form of a crescent with upward curling and with the tissue of the leaf practically black and dry like parchment. This blackening of the leaves gradually progresses down-

ward and all the petioles become black and dead. If all the leaves of a sugar beet plant are killed some time before harvest, the root usually becomes soft and may decay due to infection with different rot-producing soil organisms.

There are also many degrees of severity of nitrogen deficiency in sugar beets. A slight deficiency may cause a somewhat early yellowing of the tops, whereas a severe shortage will cause yellowing very early in the season. The result of a severe deficiency will be small yellow tops, low yield of roots and no significant response to a phosphate fertilizer. The top to root ratio may fall as low as 20 per cent for tops and 80 per cent for roots, whereas the optimum is about 35 to 40 per cent for tops and 60 to 65 per cent for roots at the time of harvest. Experiments show that a liberal application of manure, supplemented by nitrogenous fertilizers will correct nitrogen deficiency in beets. When a considerable amount of nitrogenous fertilizers is applied, phosphates also should be applied—otherwise the nutrition of beets will be unbalanced.

DEPARTMENT OF CHEMISTRY RESEARCH

By

A. R. Patton

INTRODUCTION

"A bushel of corn must begin somewhere. So must all the other tangible and visible evidence of the Arts of Husbandry.

"May it not be maintained that they begin in the play of the unseen forces that are constantly at work before our eyes and beneath our feet? Agriculture deals with change because it deals with life. Sun and wind and frost and rain from Heaven form a partnership of change. Abetted by them are the biologic forces and organisms and processes that permeate and actuate every cubic foot of soil, every blade of grass and every animal that walks the farmyard. Here are the beginnings of Husbandry. Here is the field of the chemistry of Agriculture. We study these beginnings that we may understand, predict, achieve."

Chemistry is a tool. Applied agricultural biochemistry is an attempt to understand vital processes by chemical means to aid farmers in feeding plants and animals. While chemistry in itself does not produce a single pound of beef or a bushel of wheat, when applied as a tool it is a benefactor in all agricultural production.

At the beginning of the first World War, America was just discovering the existence of the chemist. Chemistry came into its own with our entry into the war when it became necessary to sift the vital functions out of the superstructure of non-essent-

¹H. B. Knapp.

ials. The country needed production, more production, better production. It was discovered that chemists produce not only ammunition and poison gases, but food as well. By the time the war ended, America had learned the value of research chemistry.

Now, with the nation again at war, and with agricultural production again under the lash of urgent necessity, applied agricultural biochemistry is serving as a powerful tool in many ways. Because the Chemistry Research Department is doing its job by helping nearly all the other Departments of the Experiment Station, the direct practical application of the work of chemistry research to the immediate problems of agriculture is not discernible to the public. Chemistry research is helping with many problems vitally concerned with agricultural production in Montana. It is helping by determining soil deficiencies, and analyzing the fertilizers needed to correct them, in learning which grasses are best for meat and wool production, in studying how the nutrients which plants take from the soil influence their quality, their disease resistance, and their yield; and in studying mineral hunger in cattle and finding ways to alleviate it. In these and many other ways the Chemistry Research Department is serving the agriculture of Montana, using chemistry as a tool for aiding farmers in feeding plants and animals for victory.

DEPARTMENT OF DAIRY INDUSTRY

By

J. A. Nelson

The war emergency has brought a new emphasis to the research work in dairy industry. If food is to "win this war and write the peace" then emphasis must be placed on greater and more efficient food production.

The government is calling for more milk production. This increase must come from two sources—the increase in the number of dairy cows due to heifers freshening and more production from the present dairy cow population. More milk from the present number of dairy cows means more milk per cow. To obtain more milk per cow a better feeding and management program must be inaugurated. Work has been done on the effect of milk production and live weight of dairy cows when grain is added to a roughage ration in definite relation to the amount of milk produced. This experiment has demonstrated that up to a certain level of grain feeding a dairy cow will produce butterfat economically and beyond this level grain feeding is not profitable.

In order to save milk in raising dairy calves, work was done on substituting a dry meal containing skim milk powder for calf feeding. The dry meal was very satisfactory, equivalent to and more

economical than milk for calf feeding. This brings a saving in milk for "defense" and also enables farmers to retain their heifer calves for milk production later on.

Abnormal flavor in milk jeopardizes its value for market milk and also for manufacturing purposes. Some feeds impart a strong flavor to milk, especially when fed before milking. This problem has been studied, not only in raw but in pasteurized milk and the results show how milk flavor may be enhanced by proper feeding and pasteurizing methods. Better milk flavor means more milk consumption for health and better manufactured dairy products. The consumption of more milk solids should be encouraged, considering that it does not interfere with the butter-fat needed for the manufacture of other dairy products. In order to encourage a higher consumption of cultured buttermilk (which would result in a higher consumption of skim milk from which it is made) work is being done on the development of a more uniform and better flavored buttermilk. Results on improving the flavor and body characteristics are encouraging.

Due to the fact that Montana creameries must purchase almost all sour cream for butter-making, a definite quality problem in the butter-making industry of the state has evolved. The Federal Government is seizing butter on terminal markets that has a high mold mycelia count in it. In order to show the Montana butter plants the way to improvement in their sour cream supply for butter-making, work was started on the relationship of sanitary production, flavor, age and mold mycelia in cream to the grade of butter made from it. This work shows the grade of cream that must be improved or rejected if the butter made from it is to meet government standards for mold mycelia.

MONTANA GRAIN INSPECTION LABORATORY

By

W. O. Whitecomb

Direct service in testing seeds for purity and germination and analyzing grains for marketing are the contributions which the Montana Grain Inspection Laboratory is making to the war-time agricultural program in Montana. The proper selection of seed as to its freedom from mixtures of various kinds and from objectional weed seeds means much in the production of crops when maximum yields are so essential. Of equal importance is the germination or viability of this seed, since upon this depends the number of plants which are produced on a given area, and to a certain extent, the ability of these plants to make a vigorous growth and withstand unfavorable conditions. The testing of the resulting crops as to their adaptability to certain uses means much in the marketing program in any state, but more especially is this true in Montana

where quality in grain and seeds is recognized as of prime importance in marketing operations.

These services have been offered by this laboratory since 1913. The seed testing work, which was the first service offered by the laboratory, has done much to keep the subject of good seed stocks before the people and to guard against the importation of inferior seeds from other states. The grain grading work, which was started in 1917, and the protein testing, which was added in 1925, have meant much to the Montana wheat growers in obtaining the best prices for their high quality wheat.

SEED TESTING AND IDENTIFICATION

During the year ending June 30, 1941 the laboratory tested for seeding purposes, 5,930 samples of seeds, and 4,912 samples were tested during the fiscal year ending in 1942. In this work, careful attention has been given to the interpretation of the plant-producing value of the seeds and detailed reports have been sent to the farmers and dealers who submitted the samples. The methods employed have been those recommended by the Association of Official Seed Analysts and a close contact has been maintained with other seed testing laboratories in the United States and Canada.

The identification of seeds is coming to be an important part of the seed work. By means of comparison with type samples, it is possible to identify most of the samples of seeds which are submitted for this purpose, but there are certain limitations as to definite identification of varieties when only the threshed seed is at hand. In these cases, the people are advised not to use seed of unknown variety but to obtain stocks from known sources or, if possible, to use registered seed.

Mounted specimens of weed seeds are furnished by the laboratory as a means of helping the residents of the state to become familiar with the more important weeds. These are in demand for instructional work in schools and by seed dealers and others.

VEGETABLE SEED PROBLEM

Although the Montana Seed Law does not apply to vegetable seeds, and labeling requirements are not in force, as in the case of field seeds, the laboratory is equipped to render prompt service as to germination of these seeds. Vegetable seeds differ from field seeds in that they are produced under special conditions and in the past some of them have been imported from foreign countries. Because of the scarcity of certain vegetable seeds, the quality is apt to be inferior and old seed stocks may be placed on sale in the state. It is to guard against crop failures or poor stands that people are urged to have their vegetable seeds tested for germination unless they have assurance from the dealers that such seeds are up to standard.

GRAIN GRADING AND PROTEIN TESTING

Seventy-five per cent of Montana's 1940 wheat crop which was tested in this laboratory, graded No. 1 and 67 per cent of the spring and 82 per cent of the winter wheat ranked high enough in protein content to command premiums of varying degrees. It is information of this kind which is of value to wheat growers. Certificates of grade and protein content were furnished by this laboratory on over six thousand lots of wheat.

This laboratory was certified by the Commodity Credit Corporation as one of the official laboratories for testing wheat and other grains under their wheat loan program for the 1940 crop. In this work, 1,710 certificates were issued for grade and 1,466 for protein.

OTHER TESTS ON FOOD PRODUCTS

During the fiscal year of 1940-1941, fourteen carloads of whole-wheat flour, twelve carloads of rolled whole wheat cereal, and four carloads of wheat flour were tested for the Purchase and Distribution Division of the Federal Surplus Commodity Corporation of the U. S. Department of Agriculture. These products were produced by the Montana Flour Mills Company at Bozeman and Missoula. The tests involved detailed analysis for protein, ash, and moisture and certification as to the compliance of the products with specifications.

The Montana State Purchasing Agent frequently calls upon the Laboratory for analysis of flour and other cereal products which are purchased for the state institutions. Other materials, such as yeast, are sometimes tested for this agency.

Samples of flour and bread are received from housewives, millers, and bakers with the request that tests be made and information furnished as to the properties of or imperfections in the products. Services which are furnished along these lines have a far-reaching effect in that they lead to better quality of food supplies in the state.

RESEARCH WORK

In addition to the regular service work, the laboratory does some work of a research nature. This has to do with the interpretation of laboratory germination tests of seeds and milling and baking tests on wheat. The samples which are received in the service work often furnish valuable material for study and the problems involved give a good basis on which to plan research work.

In seed testing, the interpretation of the value of hard seeds in legumes has received the most attention. The Montana Laboratory has made some valuable contributions along this line.

A study of the milling and baking properties of immature and frosted wheats and the testing of new varieties of wheat have con-

stituted the major part of the research work in milling and baking. However, the wet weather in the fall of 1941, which caused a large amount of weather-damaged wheat, presented a new problem of importance in this and other states. Carefully planned studies of this weather-damaged wheat are now under way. The milling and baking characteristics of this wheat are being studied and the blending properties of the flour with those from normal wheat is receiving attention. Studies are also being made to determine how the wheat is affected when varying degrees of weathering take place. This work is being done with un-weathered wheat which is subjected to various types of weathering conditions.

DEPARTMENT OF HOME ECONOMICS

By

Jessie E. Richardson

The people of the United States are beginning to realize that our nation faces the possibility of a long, hard war. In preparation for the many demands that will be made on the people, it is essential that every citizen in the service or working at home shall, if possible, maintain a good state of health. Good health means having a strong body, firm muscles, steady nerves, a clear mind, keen eyesight, an abundance of energy, and the desire to work. Poor health undermines manpower and is a liability to a nation.

For many years, those engaged in nutritional research have been emphasizing the fact that to maintain the body and mind in a state of good health requires the regular use of certain food materials in correct amounts. These "protective" food materials include protein, a number of minerals, and a steadily increasing list of vitamins. Much technical information is already available about these factors and their occurrence in foods, but now it is necessary that this information shall be interpreted in a more popular form for practical use. This will enable the farmer to produce the food materials having the highest nutritive value and will aid the homemaker in conserving and utilizing these essential food nutrients during this time of war.

The Home Economics Department of the Montana Agricultural Experiment Station is prepared to meet this urgent need for nutritional information, as this research group has spent the past sixteen years in an extensive study of the nutritive value of vegetables and fruits grown in the state. Experimental work has been done on a total of 20 vegetables, and it has been found that *potatoes, peas, green string beans, tomatoes, cabbage, broccoli, and greens (spinach, chard, etc.)* furnish the greatest amount of essential food nutrients, while *carrots, rutabagas, parsnips, and squash* rank next in value. Unfortunately, some of our common vege-

tables were found to contain very little of the important nutrients, but furnish variety and flavor, (sweet corn, beets, radishes, lettuce, and onions). These facts should aid in efficiently planning the home or truck garden, so that available soil, water, and physical labor may be utilized to produce the more nutritious vegetables.

Among the limited number of fruits grown throughout Montana, *strawberries*, *cantaloupe*, and the *wild buffalo berry* were found to be the most nutritious, while raspberries, cherries, apples, and rhubarb were lower in nutritive value. Much of this information about vegetables and fruits has been presented in popular form in two recent publications: Bulletin 390, "Vitamin C Content of Winter Fruits and Vegetables," and Circular 165, Wall Chart, "A Guide to Vitamins and Minerals in the Family Meals."

The Home Economics Department has also made an extensive study of different methods of preservation to conserve vegetables for winter use, and the effect of preservation on their food nutrients. The results have shown that during *careful storage* (providing some ventilation, sufficient moisture and the correct temperature) potatoes, carrots, rutabagas, parsnips, cabbage and onions retained a large part of their original nutritive value. (See Station Bulletins 276, 277, 346, 349). Therefore, storage is recommended as a satisfactory method of handling these vegetables during winter months.

Canning by safe home methods is the only satisfactory method for the preservation of peas, string beans, tomatoes, and greens. While canning, followed by storage of the canned material, causes considerable loss of the vitamins B₁ and C, the loss is no greater than that caused by some other methods of preservation. Directions for home canning by safe methods at various Montana altitudes have been worked out by this department and are found in Station Circular 147 (now published by the Extension Service as Bulletin 193). For the detailed studies on the canning of certain vegetables see Station Bulletins 347, 373, 381.

A study of the vitamin C values of seasonal and ever-bearing strawberries is in progress. So far, fresh Dunlap and Gem strawberries have proved to be rich sources of vitamin C, exceeding citrus fruits. However, strawberries are perishable and must be preserved for winter use by canning, freezing, or making into jams, jellies, or preserves. Six months' storage of these products results in a very uniform loss of about 75 per cent of their original vitamin C value.

The Home Economics Department plans to devote its activities during war time to a continuation of this type of work and is prepared to cooperate in a nation-wide study of means for conserving food nutrients during the transportation, marketing, and home cooking of food products.

DEPARTMENT OF HORTICULTURE

By

F. M. Harrington

POTATOES

Experimental work with potatoes clearly shows that higher returns per unit of labor may be accomplished by following out certain specific practices.

(1) **SOILS.**—A good content of organic matter in the soil is highly essential to maximum yields, quality, and for fertilizer responses. Experimental work shows that soils depleted of organic matter very frequently have less than half the production value of soils in which the content of organic matter is good. Soils that have been cropped continuously with nothing being returned to the soil should be avoided in growing a potato crop. The plowing under of an alfalfa or sweet clover crop is to be recommended.

(2) **SEED.**—Experimental work also points out that good seed is the basis of good returns. Tests of many lots of seed potatoes show a variation in yielding power from as low as 5,000 pounds per acre to above 40,000 pounds. These differences are due to the seed alone. Labor conditions do not warrant an individual producing a yield of fifty sacks per acre. The use of certified seed generally is good insurance. The grower himself, if he is using his own seed stock, must be sure that this stock is not diseased. The index work is one of the outstanding methods, combined with roguing and good cultural practices, in holding down the amount of disease. Ring rot not only cuts the yield but also lessens the value by resulting in many rotted potatoes. This highly infectious disease can be detected and eliminated from seed stock by use of the ultra-violet lamp. The infectiousness of the disease is such that unless precautions are taken by the grower, widespread infection of the seed stock will result during the cutting operation. Stress is placed upon the value of the disinfected rotary cutting knife developed by Montana State College. The ordinary cutting of seed without precautions may mean that a trace of ring rot in the seed stock will result in a high percentage of rotted tubers in the harvested crop. The use of a disinfected cutting knife with a 1-500 strength of corrosive sublimate as a disinfectant is recommended.

(3) **FERTILIZERS.**—Commercial fertilizers mean higher yields and higher grade. Therefore, greater returns per unit of labor may be obtained. Phosphate should universally be used in all potato production at the rate of 125 pounds of treble superphosphate per acre. Responses of soils low in organic matter are limited. With a good organic content of the soil, which means

good physical condition, the returns and benefits of phosphate are very much increased. A fertilizer containing a low percentage of nitrogen very frequently results in a much improved crop over the use of phosphate alone. Ammoniated phosphate at the rate of 125 to 150 pounds per acre constitutes the most economical form of fertilizer where both nitrogen and phosphate must be applied.

(4) AMOUNTS OF SEED.—High costs of seed frequently cause growers to use minimum amounts in planting and to cut very small seed pieces. Yields and grade are more or less in proportion to the size of seed pieces and amount of seed planted. It is a mistake, particularly under irrigated conditions, to plant a seed piece under 1½ ounces in size. By using more seed per acre the grower can reduce the number of acres used in producing definite total tonnages. A combination of proper soils with organic matter combined with good seed, the use of all precautions to prevent ring rot spread, plus commercial fertilizers and sufficient seed per acre are outstanding contributors to maximum returns per labor unit.

(4) CUTTING OF SEED.—Growers may spread the planting operations over a longer period by cutting their seed in the late winter or early spring provided the cut seed is properly handled. Proper conditions, as demonstrated by experimental work, mean that this cut seed must be held for a minimum of three days at a temperature of 60°, with a high humidity. During this period the seed must be spread out in a comparatively shallow layer not more than six inches deep. The cut surfaces will heal and the cut pieces may then be sacked and returned to the cellar. Immediate sacking and returning to a cool cellar destroys the seed value. This operation results in a smaller number of labor units at the actual time of planting.

VEGETABLES

Factors which hasten maturity of vegetables add to the values of such crops by either lengthening their season or giving the maturity necessary for storage.

(1) TOMATOES.—Earlier ripening of tomatoes has been secured by four methods: (a) staking and tying vines, (b) pruning to a single or double stem, (c) fertilizer treatment of transplants, and (d) field application of phosphate.

Staking and pruning has been previously reported. Fertilizer treatments of transplants result in earlier fruiting and heavier yields. Two grams of nitrate of soda plus 2 grams of treble superphosphate per plant applied to the soil in which the transplant is grown gives the above results. In practical use this means 4 ounces of each of the materials in a bushel of soil.

Two hundred pounds of treble superphosphate per acre is an

added factor in earlier maturity and heavier yields.

(2) ONIONS.—Best yields and best maturity are obtained by using transplants grown in soil fertilized with phosphate and then in the field applying phosphate. These practices mean mature crops for storage.

(3) VINE CROPS.—Cucumbers and squash should be started under hot kaps. This practice eliminates spring frost hazards and allows earlier planting, thereby lengthening the season. Phosphate, also, should be used. The combination of these two practices makes a difference of close to three weeks in maturity.

(4) USE OF COMMERCIAL FERTILIZERS.—Experimental results show that fruits and vegetables respond beneficially to applications of commercial fertilizers, particularly phosphate. Phosphate universally has the effects of earlier maturity combined with an improvement in the quality of the crop. Also with all vegetable crops this fertilizer response is greatest if physical conditions of the soil are good, which means, generally, that the organic content of the soil is high. High organic and nitrogen content of soils with a low phosphate content results in delayed maturity and lower quality of the product. The best fertilizer program for Montana in the face of shortage of nitrogenous fertilizers would involve, therefore, a combination of the two factors of soil condition and applications of phosphate. The latter material is not restricted by war demands as are nitrogenous fertilizers.

NEW AND EARLY MATURING VEGETABLE VARIETIES

Most parts of Montana need to change to early maturing varieties in order to get the maximum out of a garden. Station tests of varieties in the past year show that the variety of sweet corn, Spancross, is a high quality corn and is much earlier than Golden Bantam, Sunshine and some of the other varieties which we have been growing. Spancross in our tests was practically a month ahead of Golden Bantam in producing roasting ears.

A tomato variety now under test in the plots is Harkness. This variety has been one of our earliest to ripen and one of the heaviest yielders combined with a minimum of cracking. Also the fruit is of good size which is contrary to what is found in most early varieties.

DEPARTMENT OF RURAL ENGINEERING

By

O. W. Monson

The Department of Rural Engineering has seven active research projects covering various practical problems of importance to Montana farmers.

The possibilities of water wheels for small power plants has been studied for several years and the problems involved in the design and construction of water wheels and power transmission are explained in Extension Bulletin 197 and Experiment Station Bulletin 398, both by Monson and Hill. The development of small power plants is desirable wherever possible in order to conserve on farm labor and enable farmers to reach production goals.

Concerning the raising of crops under irrigation, there is much to be learned about the water requirements of various crops and also methods of irrigation and when to irrigate. Studies dealing with the irrigation of seed and canning peas over a period of five years have shown that the yield of peas may be greatly affected by the time or stage of growth when water is applied. Irrigation applied too early in the season often has been found to reduce the yield and to create a need for frequent follow-up irrigations later. This means extra work and an extra amount of water.

Further studies along the line of irrigation practices conducted at the Huntley Field Station have shown that it is common practice to apply excessive amounts of water to field crops, which often results in a waste of water through surface runoff and loss of fertility.

Range improvement through the conservation of flood water is being investigated at the U. S. Range Livestock Experiment Station at Miles City and studies have shown that the average runoff from a square mile of range land in eastern Montana is enough to irrigate about 25 acres of land and produce over 25 tons of feed. This runoff water may be conserved by the construction of rather simple ditch and dike systems. The results of the studies thus far are described in Station Bulletin 380 by Monson and Quesenberry.

Rural Electrification has brought to many farms in Montana an electrical chore boy and hired man. Mimeographed Circular 35 by Hill, on the cost of grinding feed with electrical feed grinders has recently been released. Other studies deal with the operation of stokers, electric fences, and milking machines and have been reported in the form of Information Leaflets. These studies are being continued insofar as limited facilities will permit.

The problem of equitably distributing the available water supply in Montana has increased with the expansion of various state, federal, and private irrigation programs. It involves a tabulation of existing water rights and the compilation and analysis of all available information on stream flow in Montana.

The cooperation of the Works Progress Administration with the Montana Agricultural Experiment Station and the State Engineer has made it possible to undertake this project and the work of tabulating water rights is progressing over the entire state.

A tabulation of the water right laws of Montana and a brief discussion of water rights have been published as Special Reports 8 and 9. Summaries of all available stream flow data have been pre-

pared as Special Reports 10, 11, 12, and 13 covering the Missouri River below Fort Benton, above Fort Benton, the Yellowstone, and Clark's Fork of the Columbia. These reports are not available for general distribution but are in demand by planning and development agencies concerned with the utilization of Montana land and water resources.

One of the most important activities of this department is the making of snow surveys on the watersheds of Montana. This work is carried on in cooperation with the State Engineer, the Irrigation Division of the Soil Conservation Service and other Federal agencies. These snow surveys made during the spring months serve as a basis for predicting several months in advance the water supply which will be available for irrigation, for power, and for storage in Fort Peck Reservoir for navigation regulation on the Missouri River. The studies are designed to improve the accuracy of the forecasts and thereby increase their value.

DEPARTMENT OF VETERINARY RESEARCH

By

Hadleigh Marsh

The ultimate goal of the work of the Montana Veterinary Research Laboratory is to develop information which will enable Montana stockmen to prevent losses which are caused by livestock diseases. Much information on this subject is available from other sources, but this laboratory has attacked a number of problems which are more or less peculiar to this section of the country. During the past 30 years, some contributions have been made which are of much value to Montana stockmen.

Referring particularly to methods of disease control which have been wholly or in part the result of work done by this department, we call attention to the following:

USE OF IODIZED SALT.—Investigation of hairlessness and goiter in new-born pigs developed the fact that losses of new-born pigs, lambs, calves and colts from goiter can be definitely prevented by the use of iodized salt for the breeding females during the period of pregnancy.

PHOSPHORUS SUPPLEMENTS FOR CATTLE.—The Veterinary Department has, for many years, advocated the use of phosphorus supplements, principally bone-meal, in large areas of the state where the feed is deficient in phosphorus, and where beef production per unit can be definitely increased by supplying the needed phosphorus. There is need to develop better means of overcoming this deficiency under range conditions.

BLACKLEG IN SHEEP.—While the need of vaccinating cattle against blackleg is well recognized, this department established the fact that blackleg at times occurs in sheep. Many stockmen

do not yet realize that fact, and probably take some losses which could be prevented, although we do not advocate general vaccination of sheep.

PREVENTION OF NAVEL INFECTION IN LAMBS.— This department introduced in Montana the method of navel disinfection with iodine for lambs produced under shed-lambing conditions. This practice should be made universal, as navel infection is still responsible for the loss of many lambs every year.

DYSENTERY OR SCOURS IN YOUNG LAMBS.— A large amount of work has been done by this department in the investigation of the cause and treatment of this condition. It was found that prevention of such loss is primarily a sanitation problem, and the practical result of this work is in evidence in equipment and management of lambing plants on the more progressive ranches. This "missionary" work should be extended.

ARTHRITIS IN LAMBS (stiff lambs).— Experimental work with a joint infection causing one form of "stiff lambs," resulted in control by navel disinfection and proper methods of docking. Again, more mutton can be saved for the country by universal application of these findings.

FOOT-ROT IN SHEEP.— Work at this laboratory showed that foot-rot infection dies out very quickly on premises, after infected sheep are cured or removed. A practical method of treatment was developed, which, under supervision of deputy state veterinarians, should be used wherever foot-rot appears in sheep.

VACCINATION AGAINST "BLACK DISEASE" IN SHEEP.— West of the Continental Divide, where liver flukes occur, there have been serious losses of sheep, consisting of sudden deaths, one or two at a time, during the fall months. These were found to be due to a liver infection, and this laboratory developed a successful vaccine. Sheep owners in western Montana should be informed of this condition and that a commercial vaccine is available.

CONTROL OF BANG'S DISEASE IN RANGE CATTLE.— Although the development of a vaccine against Bang's disease has simplified the control of the disease, we feel that the findings in the work of this laboratory with the cow herd of the U. S. Range Livestock Experiment Station at Miles City are of much value in controlling the disease in range cattle. By the use of a field blood test which can be completed while the animals are in the chute, range cattle can be tested with only one handling. The work at Miles City showed the fundamental importance of a short breeding season. Where the breeding season was limited to two months, an actively infected herd could be freed of reactors by one or two fall tests. We believe that culling the herd on this basis should be done when vaccination is started.

COCCIDIOSIS IN CATTLE.— The results of our experiments with coccidiosis (bloody diarrhea) of cattle indicate that losses from this disease can be largely prevented by certain methods of management of calves at weaning time and during their first winter. These should be put into effect as widely as possible.

COCCIDIOSIS IN FEED LOT LAMBS.— Preliminary experiments carried out in the fall of 1941 in the Sidney lamb-feeding area indicate that much of the loss from coccidiosis in lambs can be prevented by certain methods of handling and feeding during the first three weeks after the lambs leave the range. This information should be translated into increased fat lamb production per feeding unit.

DEPARTMENT OF ZOOLOGY AND ENTOMOLOGY

By

Harlow B. Mills

This department is endeavoring primarily to discover new or better methods of animal pest control. The work deals mainly with insects of immediate interest to farmers. Present-day rapid transportation makes it essential, however, that the department be constantly on the watch for introductions of new pests.

During the past two years several species of insects new to Montana have been recorded. The European earwig was first reported from the state in 1939. New foci of infestation not hitherto reported are Missoula and Bozeman Hot Springs. Control measures are given in Montana Agricultural Experiment Station Bulletin 384.

Among the introduced pests discovered during the past biennium are the spinose ear tick, screw worm fly, and sweet clover weevil.

Sugar beet webworm studies have continued during the past two years, with primary emphasis on the physiology of the insect, in an attempt to allow prediction of infestations. Experimentation on the potato and tomato psyllid is now gradually resolving itself into an attempt to obtain information which will allow us to predict outbreaks.

A new project has been established in cooperation with the Department of Animal Industry in an attempt to measure the importance of pocket gophers on mountain sheep ranges. This is especially timely with the increased emphasis on animal production and the present need for meat production.

Projects on stored grain pests have been instituted to assist in this critical and growing problem.

DEPARTMENT OF LIBRARY AND PUBLICATIONS

By

F. B. Linfield

During the period covered by this Annual Report, the publications of the Montana Agricultural Experiment Station were as follows: 21 Bulletins*; 6 Circulars*; 9 Mimeograph Circulars*; 14 Special Reports*; 2 Departmental Information Leaflets*; 1 Departmental Information Circular*; and in addition 19 articles published in various technical and scientific papers and journals.

BULLETINS:

- No. 384—Montana Insect Pests, 1939 and 1940, Twenty-eighth Report of the State Entomologist. Harlow B. Mills, State Entomologist. January, 1941. 5000 copies, 28 pages.
- No. 385—Land Ownership and Tenure on the Huntley Irrigation Project; An Analysis of Their Evolutions and Implications. P. L. Slagsvold, Dept. of Agr'l. Economics. January, 1941. 3500 copies, 19 pages.
- No. 386—Control of Bacterial Ring Rot of Potatoes, with Special Reference to the Ultraviolet-Light Method for Selecting Disease-Free Seed Stock. V. E. Iverson and H. C. Kelly, Dept. of Horticulture. December, 1940. 3500 copies, 15 pages.
- No. 387—Commercial Fertilizer Report for 1940. John T. Kelly, State Commissioner of Agriculture. February, 1941. 5,000 copies, 8 pages.
- No. 388 Dry-land Pasture Experiments at the Judith Basin Branch Station. Ralph M. Williams, Supt. of Branch Station, and A. H. Post, Dept. of Agronomy. March, 1941. 7500 copies, 25 pages.
- No. 389—Life History and Control of the Sugar-beet Webworm, *Loxostege sticticalis* (L.). J. H. Pepper and Ellsworth Hastings, Dept. of Entomology. April, 1941. 2000 copies, 32 pages.
- No. 390—Vitamin C Content of Winter Fruits and Vegetables. Jessie E. Richardsn and Helen L. Mayfield, Dept. of Home Economics. May, 1941. 7500 copies, 16 pages.
- No. 391—Agricultural Planning: Its Economic and Social Aspects. Carl F. Kraenzel and O. A. Parsons, Dept. of Agr'l. Economics. June, 1941. 2500 copies, 44 pages.
- No. 392—Potato Yields and Quality as Affected by Commercial Fertilizers. F. M. Harrington and V. E. Iverson, Dept. of Horticulture, and W. E. Pollinger, Sup't Horticulture Branch Station. June, 1941. 6000 copies, 20 pages.
- No. 393—Studies on Control of Bunt of Wheat. H. E. Morris, Botanist and A. M. Schleuber, Associate Agronomist. July, 1941. 2500 copies, 20 pages.

*Montana residents may obtain the publications of this Station without cost by writing to the Library-Publications Department, Montana Agricultural Experiment Station, Bozeman, Montana, and indicating the number and title of the publications desired, or by applying to the Agricultural Extension Agent of your county. The Station will gladly place your name on the mailing list to receive publications of special interest as issued.

**Mimeograph Circulars, Special Reports, Departmental Leaflets and Departmental Circulars are all issued in mimeograph form in limited editions, and are chiefly for inter-departmental information. They are not available either for general distribution or for library files.

- No. 394—Trends in Market Prices for Montana Farm and Ranch Products. Harold G. Halcrow, Dept. of Agr'l. Economics and Jay G. Diamond, Agr'l. Marketing Service. August, 1941. 7000 copies, 24 pages.
- No. 395—Fertilizer Investigations in Montana in 1940. A. H. Post, Dept. of Agronomy. August, 1941. 5500 copies, 20 pages.
- No. 396—The Grain Inspection Laboratory: Twenty-five Years' Service to Montana. W. O. Whitcomb, Sup't. of Grain Laboratory. September, 1941. 5000 copies, 20 pages.
- No. 397.—Record of Performance in Hereford Cattle. R. T. Clark, Dept. of Animal Industry, and Bradford Knapp, Jr., A. L. Baker, J. R. Quesenberry, Bureau of Animal Industry, U. S. D. A. January, 1942. 5000 copies, 30 pages.
- No. 398—Overshot and Current Water Wheels: Design, Construction and Installation for Small Power Developments on Ranch and Farm. O. W. Monson and Armin J. Hill, Dept. of Irrigation and Drainage. February, 1942. 3500 copies, 32 pages.
- No. 399—Oat Variety Tests in Montana. A. M. Schleuber, J. J. Sturm, R. H. Bamberg, Dept. of Agronomy in cooperation with the Bureau of Plant Industry, U. S. D. A. March, 1942. 6000 copies, 20 pages.
- No. 400—Growth and Production Factors in Range Cattle. Bradford Knapp Jr., A. L. Baker, J. R. Quesenberry, Bureau of Animal Industry, U. S. D. A. and R. T. Clark, Department of Animal Industry, cooperating. March, 1942. 7500 copies, 16 pages.
- No. 401.—Studies on Large and Small Type Hereford Cattle. R. R. Woodward, R. T. Clark, J. N. Cummings, Dept. of Animal Industry. February, 1942. 5000 copies, 20 pages.
- No. 402—Commercial Fertilizer Report for 1941. Albert H. Kruse, State Commissioner of Agriculture, and W. E. Carlson, A. R. Patton, Dept. of Chemistry. May, 1942. 5000 copies, 12 pages.
- No. 403—Soils of Golden Valley County. L. F. Gieseke, Dept. of Agronomy, cooperating with Division of Soil Survey, Bureau of Plant Industry, U. S. D. A. April, 1942. 2000 copies, 52 pages.
- No. 404—Standards and Procedures for Classification and Valuation of Land for Assessment Purposes. H. H. Lord, S. W. Voelker, L. F. Gieseke, Montana Agr'l. Experiment Station in cooperation with Bureau of Agr'l. Economics, U. S. D. A. June, 1942. 6000 copies, 28 pages.

CIRCULARS:

- No. 161—Suggestions for Control of Bacterial Ring Rot of Potatoes. V. E. Iverson and H. C. Kelly, Dept. of Horticulture. December, 1940. 5000 copies, 6 pages.
- No. 162—The Sugar-beet Webworm in Montana. J. H. Pepper and Ellsworth Hastings, Dept. of Entomology. April, 1941. 5000 copies, 8 pages.
- No. 163—Recommended Practices for Control of Bunt in Wheat. H. E. Morris, Botanist and A. M. Schleuber, Associate Agronomist. August, 1941. 6000 copies, 4 pages.
- No. 164—Some Causes of Infertility in Montana Soils. Edmund Burke, Chemist, and H. E. Morris, Botanist. November, 1941. 6000 copies, 23 pages.
- No. 165—Wall Chart: A Guide to Vitamins and Minerals in the Family Meals. Jessie E. Richardson and Jean T. Chase, Dept. of Home Economics. December, 1941. 20,000 copies, 16 pages.
- No. 166—Potato Diseases in Montana and Their Control. H. E. Morris,

M. M. Afanasiev, Dept. of Botany and Bacteriology. June, 1942. 8000 copies, 44 pages.

JOURNAL ARTICLES:

- No. 127—Buffering Capacity and Composition of the Blood and Regurgitated Digestive Juices of the Mormon Cricket. J. H. Pepper, F. T. Donaldson and Ellsworth Hastings. *Physiological Zoology*, Vol. 14, October 1941. Pp. 470-475.
- No. 141—Determination of Boron in Plant Material. Donald R. McCormick. *Chemical Analyst*, Vol. 31:2, May, 1942. Pp. 35-38.
- No. 142—Standardization of Stained Br. Abortus Antigen for the Whole Blood Test. Hadleigh Marsh. *American Journal of Veterinary Research*, Vol. 2, January, 1941. Pp. 46-49.
- No. 143—Enteritis in Sheep Caused by Infection with the Protozoan Parasite *Globidium Gilruthi*. Hadleigh Marsh and E. A. Tunncliff. *American Journal of Veterinary Research*, Vol. 2, April, 1941. Pp. 174-177.
- No. 144—A Study of *Actinobacillus Lignieresii* from Sheep Affected with Actinobacillosis. E. A. Tunncliff. *Journal of Infectious Diseases*, Vol. 69, July-August, 1941. Pp. 52-58.
- No. 145—Fall-sown Spring Wheat Susceptible to Dwarf Smut. R. H. Bamberg. *Phytopathology*, Vol. 31, No. 10, October, 1941. Pp. 951-952.
- No. 147—The Economic Importance of Livestock in Montana. G. H. Craig. *The Montana Stockgrower*, Vol. 2, No. 8, August, 1940.
- No. 148—Symptoms of Phosphate Deficiency of Sugar Beets. M. M. Afanasiev. *Plant Diseases Reporter*, Vol. 25, No. 16, September, 1941. Pp. 414-415.
- No. 149—Another Infestation of a School Building by *Oeciacus vicarius* Horvath. H. B. Mills and D. J. Pletsch. *Journal of Economic Entomology*, Vol. 34, No. 4, September, 1941. P. 575.
- No. 150—Field Observations on the Effect of Tillage on Grasshopper Eggs. H. B. Mills. *Journal of Economic Entomology*, Vol. 34, No. 4, August, 1941. P. 589.
- No. 151—Seedling Diseases of Sugar Beets; Control of Seedling Diseases under Field Conditions. M. M. Afanasiev and H. E. Morris. *Proceedings of the American Society of Sugar Beet Technologists*. Part 1, 1940. Pp. 216-219.
- No. 152—Distribution of Sodium Arsenite and Diluent in the Dust Cloud. E. Hastings. *Journal of Economic Entomology*, Vol. 34, No. 6, December 1941. P. 769.
- No. 155—A Filterable Virus Demonstrated To Be the Infective Agent in Ovine Balano-Posthitis (Veneral Disease of Sheep). E. A. Tunncliff and Peter H. Matischeck. *Science*, Vol. 94, September 1941. P. 2438.
- No. 156—Seasonal Changes in the Lignin and Cellulose Content of Some Montana Grasses, Part I. A. R. Patton and L. F. Gieseke. *Journal of Animal Science*, Vol. I, No. 1, January 1942. Pp. 22-26.
- No. 158—The Effect of Some Insecticides on the Immature Stages of the Potato and Tomato Psyllid, *Paratrioza cockerelli*. D. J. Pletsch. *Journal of Economic Entomology*, Vol. 35, No. 1, January 1942. Pp. 58-60.
- No. 159—Rapid Determination of Sodium in Waters and Soil Extracts. D. R. McCormick and W. E. Carlson. *The Chemical Analyst*, Vol. 31, February, 1942. P. 15.

- No. 160—Accuracy of the Ultraviolet-Light Method for Selecting Ring Rot-Free Potato Seed Stocks. V. E. Iverson and F. M. Harrington. *American Potato Journal*, Vol. 19, No. 4 April 1942. Pp. 71-74.
- No. 166—Nitrogen and Phosphorus Deficiencies in Sugar Beets. W. E. Carlson and M. M. Afanasiev. *Through the Leaves*, Vol. 30, May-June 1942. Pp. 6-9.

MIMEOGRAPH CIRCULARS:

- No. 30—Abstract of Montana State Laws Relating to the Office of County Treasurer. Dept. of Agr'l. Economics. December 1940. 300 Copies, 59 pages.
- No. 31—Local Public Finance Situation in Daniels County, Montana. S. W. Voelker. December 1940. 300 copies, 52 pages.
- No. 32—What Is Happening to Montana County Expenditures? R. R. Renne. February 1941. 300 copies, 22 pages.
- No. 33—Statistical Summary of Prices Received by Montana Farmers and Ranchers, by Months, August 1909-December 1940. Harold G. Halcrow. June 1941. 500 copies, 71 pages.
- No. 34—Credit Costs, Comparative Costs of Borrowing Funds under Commonly Used Finance Plans. Joe L. Livers. June 1941. 300 copies, 27 pages.
- No. 35—Cost of Grinding Feed Grains with Electric Feed Grinders. Armin J. Hill. February 1942. 500 copies, 5 pages.
- No. 36—Montana County Expenditures: 1941. R. R. Renne. January 1942. 400 copies, 20 pages.
- No. 37—Montana Population Changes and Prospects. R. R. Renne and H. H. Plambeck. April 1942. 500 copies, 12 pages.
- No. 38—Montana Farm-Land Values. R. R. Renne. May 1942. 500 copies, 17 pages.

DEPARTMENTAL INFORMATION LEAFLETS:

Trends in Montana's Poultry Production. O. A. Parsons, Dept. of Agr'l. Economics. Mimeo. 300 copies, 6 pages, December 1940.

Organization of the Department of Agriculture. O. A. Parsons, Dept. of Agr'l. Economics. Mimeo. 300 copies, 28 pages, March, 1941.

DEPARTMENTAL INFORMATION CIRCULAR:

Costs of Producing and Distributing Market Milk in the Billings-Laurel Area of Montana. Roy Blanch, Dept. of Agr'l. Economics. Mimeo. 300 copies, 14 pages, October 1941.

SPECIAL REPORTS:

- No. 1—Preliminary Report on Local Public Finance Situation in Sheridan County, Montana. S. W. Voelker, Bureau of Agr'l. Economics, U. S. D. A. 500 copies, 56 pages, February 1941.
- No. 2—Local Public Finance Situation in Roosevelt County (Preliminary Report). S. W. Voelker, Bureau of Agr'l. Economics, U. S. D. A. 500 copies, 59 pages. February, 1941.
- No. 3—Bibliography of Publication and Reports Representing Results

- of Research Projects in which Works Progress Administration Has Participated. February, 1942.
- No. 4—Abstract of Montana State Laws Relating to the Office of County Treasurer. 300 copies, 59 pages. February 1941.
- No. 5—Local Public Finance Situation in Daniels County, Montana (Preliminary Report). Stanley W. Voelker, Bureau of Agr'l. Economics, U. S. D. A. 300 copies, 52 pages. February, 1941.
- No. 7—Abstract Montana Law Relating to Office of Clerk and Recorder. Dept. of Agr'l. Economics with Assistance of W. P. A. 300 copies, 41 pages. February, 1941.
- No. 8—Part I. Water Right Laws in Montana (Vol. I. Early Development and Abstracts of Water Right Laws). Montana Agr. Exp. Station, State Engineer, State Water Conservation Board, State Planning Board with Assistance of W. P. A. 262 copies, 95 pages. February, 1941.
- No. 9—Part I.—Water Right Laws of Montana (Vol. II, Irrigation Enterprises). 150 copies, 47 pages. February, 1941.
- No. 10—Part II. Water Supply (Vol I, Stream Flow Data—Yellowstone River Drainage—includes Little Missouri River Drainage). 101 copies, 128 pages. February, 1941.
- No. 11—Part II. Water Supply (Vol. II, Stream Flow Data—Missouri River Drainage Above Fort Benton). 100 copies, 177 pages, February, 1941.
- No. 12—Part II. Water Supply (Vol. III, Stream Flow Data—Missouri River Drainage Below Fort Benton). 102 copies, 236 pages. February, 1941.
- No. 13—Part II. Water Supply (Vol. IV, Stream Flow Data—Columbia River Drainage—includes St. Mary's River Drainage). 100 copies, 164 pages. February, 1941.
- No. 14—Abstracts of Montana State Laws Relating to the Office of *County Commissioners* Together with Annotations. W. P. A. and Dept. of Agr'l Economics. 300 copies, 210 pages. February, 1942.

RESEARCH AT THE BRANCH STATIONS

HORTICULTURE BRANCH STATION

By

W. E. Pollinger

POTATOES

A fertilizer program involving nitrogen, phosphorus and boric acid is conducive to best yields of potatoes in western Montana. Boric acid is an element being added to recommended fertilizers within the last year. This is a deficiency element in most soils in western parts of the state. Its use is recommended in a fertilizer program involving both nitrogen and phosphates or either of these

elements. Used alone, boric acid responses are not noticeable. It is important to be careful in the amount of boric acid used. A small amount is beneficial but a considerable quantity may be distinctly detrimental. Experimental results show that 3 pounds of boric acid is a sufficient amount to be used with 100 pounds of treble superphosphate or ammoniated phosphate. Boric acid has increased yields beyond those obtained with nitrogen and phosphate mixtures.

Organic matter is also necessary for best yields. Fertilizer responses in soils low in organic matter have in some sections been practically negligible. In the same area and on the same farm, good responses are the rule in fields where the organic matter is plentiful. Fields continuously cropped, without attention to keeping up the soils, are not good fields to select for the next potato crop. Alfalfa land constitutes, under irrigation at least, the best potato land, particularly if the last cutting is plowed under.

FRUIT

Tests on apples and cherries indicate the desirability of using boric acid—applying it to the soil under the branch spread of the trees. With apples, boric acid has improved the fruit crop and the general health and vigor of the tree. It completely corrects drought spot. Drought spot-affected trees are poor in vigor with small foliage and restricted growth. Eight ounces of boric acid per tree applied once in three to four years is sufficient. While the results have been particularly noticeable on old apple trees, evidence has appeared to indicate that cherry trees are also benefited. Boric acid seems to be one of the factors affecting uniform color development of the fruit and may also be a contributing factor to the prevention of fruit cracking. Earlier maturity of the cherry tree is also hastened by boric acid and this may be a means of reducing losses from winter injury.

COVER CROPS IN ORCHARDS

Sweet cherry orchards in the Flathead Lake region are benefited by permanent leguminous cover crops. Winter injury is much less in cover-cropped orchards than in clean-cultivated orchards. Cover crops help to determine the character of fruit produced. The fruit is firmer, more uniform in color, and is slightly later in ripening.

Under conditions where cover crops are not feasible because of moisture shortage, it appears that cultivating early in the season only is to be recommended. This cultivation is of value from the standpoint of covering the commercial fertilizer applied. Such orchards have superior hardiness over those orchards where cultivation is carried into midsummer.

PRE-HARVEST IRRIGATION OF SWEET CHERRIES

Moisture is a distinct factor in determining size and firmness of cherries. It is especially important to have good moisture at the time the fruit is developing and ripening. Irrigation up to the actual harvesting date is necessary if maximum size, yields and firmness of fruit is to be secured.

THE HUNTLEY BRANCH STATION

By

Daniel Hansen, Superintendent

The Huntley Branch Station, which is operated cooperatively by the Montana Experiment Station and the U. S. Department of Agriculture, conducts investigations in the production of both irrigated and dry-land field crops as well as in the production and management of livestock, including dairy cattle, hogs and sheep.

Experiments that have been carried on over the 32-year period since the station was established have developed basic information on methods of crop and livestock production that is of particular value to local farmers at this time when added food supplies are needed as an essential contribution in the present national emergency.

IRRIGATED FIELD CROPS

Experiments with irrigated field crops have included crop rotations, cultural methods and soil fertility investigations, crop disease and insect control, testing and developing new crop varieties and the utilization of crops and crop by-products through the use of livestock.

IRRIGATED CROP ROTATIONS.— In the better rotations that include leguminous crops such as alfalfa or pastured sweet clover and the use of barnyard manure, it was found that original high yields have been maintained or improved, while in untreated continuous cropping and the short untreated rotations crop yields soon declined to such low levels as to be unprofitable. The use of barnyard manure was found to be particularly essential in the continued production of profitable yields of sugar beets. There is evidence also that in some cases the use of phosphorus fertilizer is beneficial to beets and to certain other crops.

The value of manure in increasing yields of beets is indicated in the results of comparable manured and unmanured rotations. In six pairs of such rotations, in which the crops and sequence in each were identical, the rotations in which the ground for beets

was manured produced a 30-year average yield of 14.94 tons of beets per acre, as compared to a yield of 8.45 tons in comparable rotations not manured. This leaves a yield difference of 6.49 tons to be credited to the effect of the manurial application. Other crops in the rotations, while they did not receive a direct application of manure, also returned increased yields from the residual effect of manure applied to the beets. Potatoes in four such rotations yielded an average of 242.2 bushels per acre as compared to the yield of 201.7 bushels in rotations without manure. Similarly, oats returned a 30-year average yield of 83.1 bushels in manured rotations as against 76.5 bushels in rotations not manured.

The use of alfalfa in a rotation is desirable for its effect on yields of succeeding crops, particularly such crops as potatoes, corn and small grains, although for sugar beets it was found beneficial to make regular applications of barnyard manure in alfalfa rotations to maintain profitable yields.

In 2- and 3-year rotations of small grains and potatoes, or beets, yields within a few years were at such low levels as to be unprofitable.

MAXIMUM CROP PRODUCTION.—Based on results in the higher yielding crop rotations and on other cropping work at the station, an experiment to determine the maximum yielding capacity of soils of the Huntley Station was started in 1926. In planning this experiment, such combined cultural and crop sequence practices were followed as had been found, in the earlier experiments, to return high yields. Manure, at the rate of 16 spreader loads per acre, was applied to the row crops, sugar beets, corn, potatoes and beans, and also in some years to alfalfa. Manure was thus applied to all of the land in 6 of the 11 years of the crop rotation cycle. Phosphate fertilizer was applied to sugar beets and grain crops and in two seasons to alfalfa.

Average yields per acre in this cropping experiment, over the 16-year period, were as follows: alfalfa (3rd year) 6.45 tons; corn, 75.3 bushels; oats, 103.8 bushels; sugar beets, 20.46 tons; beans, 50.9 bushels; potatoes, 432.1 bushels; wheat (10 years only), 54.1 bushels; and barley (4 years only), 89.2 bushels.

While highly intensive cultural practices were followed in this experiment, it was found that net returns per acre were fully equal or superior to returns from the better rotations as described previously.

From these results it is apparent that soils of the Yellowstone Valley area are capable of producing much more per acre than they are yielding generally at present. To obtain this increase in production would of course involve an increase in livestock production, either in stock kept on farms the year around or in stock brought in for winter feeding. Such increases in per acre

production would add materially to needed food supplies and should result in increased profits to farm operators.

IRRIGATED PASTURES.—Experiments conducted at the Huntley Station over a long period of years have led to the development of the so-called Huntley Permanent Pasture Mixture. This pasture mixture, which includes a variety of grasses and clovers found to be particularly suitable for local conditions, will carry 2 cows or 6 to 8 ewes and their lambs per acre, over a grazing period of 5 months.

The mixture and rates of seeding are as follows:

Pasture Mixture	Rate of Seeding Pounds per Acre
Smooth Brome Grass.....	3 to 4
Kentucky Blue Grass	4 to 6
Orchard Grass	4 to 6
Meadow Fescue	3 to 4
White Clover	1 to 2
Alsike Clover	1 to 2
<u> Total</u>	<u>16 to 24</u>

LAMB FEEDING EXPERIMENTS

The winter fattening of range lambs has become an important industry in the Yellowstone Valley in recent years. Experiments in feeding conducted at the Huntley Station by the Animal Industry Department have developed information of much importance to local feeders, and have shown the value of locally grown feeds for this purpose.

Tests of various grain supplements for feeding lambs have shown that oats, when fed with either dried or wet beet pulp and alfalfa hay, was superior to No. 2 yellow corn, barley, or soft wheat, in finishing lambs for market. This combination of feeds is now in general use in most of the area.

WAR-TIME APPLICATION OF RESEARCH IN DRY-LAND AGRICULTURE HUNTLEY, MONTANA—1941-42

By

A. E. Seamans, Associate Agronomist

Research concerning the possibilities and limitations of agriculture in the plains area of Montana was begun at the Huntley Field Station in 1912 and has been continued without interruption to the present year.

The basic information derived from these studies was used

extensively by farmers and others interested in maintaining, or stepping up, agricultural production as an essential contribution toward winning World War I, and the additional data accumulated since that period has made this information of still greater value toward winning the present conflict. A summary of some of the more important results of this work follows.

CLIMATIC RECORDS.— A complete record of precipitation, wind velocity, evaporation, humidity and temperatures has been kept at the station since its establishment. These data, when correlated with soil condition and crop behaviour, have determined rather definite boundaries within which dry-farming activities must be confined.

SOIL MOISTURE STUDIES.— A comprehensive study of the accumulation, percolation, conservation and depletion of soil moisture has been maintained during the life of the dry-land experiments by means of systematic soil samplings and moisture determinations made through each growing season. These studies, carried on in connection with the climatic observations and cropping tests, have provided practical information on tillage best adapted to soil moisture storage and the relative efficiency of various crops in soil moisture usage.

GRAIN CROPS AND TILLAGE.— These investigations have clearly shown the rather severe conditions imposed upon dry farming in the plains section of Montana as a result of climatic factors and limited soil moisture supply. To overcome the somewhat adverse circumstances it has been necessary to employ only the most hardy kinds and varieties of crops, and in the case of annual crops, those that will make a quick early-season growth and mature before the onset of severe drought or early frost. Satisfactory crop varieties are constantly being developed and in the production activities of war-time agriculture no effort should be wasted by farmers through the use of untried or unsuited crops.

Efficiency of tillage procedure is also an important war-time economy which may be given more attention by many dry-land farmers. Experiments have shown that tillage which will leave the surface soil in a physical condition to readily absorb precipitation and which will destroy weeds is most essential. Plowing deeper than six inches, subsoiling, plowing a dry and cloddy soil, plowing corn stubble land for small grains, or plowing under green manure crops are generally wasted effort as well as expensive. The same and usually more profitable results would entail from shallow plowing when the soil is moist, planting a grain crop on disked corn land, and using fallow in place of green manure. Listing instead of plowing, according to these experiments, has presented a further means of effecting economy in tillage.

The use of diversified crops in a good systematic rotation em-

ploying approved tillage practices has not only produced higher and more economical yields per acre of rotation, but has distributed the risks of loss, suggested the use of livestock in connection with the cropping program, controlled weeds, and provided for greater utilization of farm equipment and labor. The crop rotation experiments have shown that, for example, including corn in a rotation with small grains has increased the yield of grain per acre of rotation by from 20 to 100 per cent above the yields from similar rotations without corn. The extended use of corn and other feed grains would seem to be justified by the war-time demand for increased meat production.

Winter wheat has been the most dependable of the small grain crops at Huntley and has also been the best cash crop. The per acre values of the spring-sown small grains have generally been less than that of winter wheat, but have been about equal to each other. The response of spring grains to tillage methods and crop sequence has also been about the same, indicating that such crops as spring wheat, oats and barley might be used interchangeably in a cropping program, thus broadening the opportunities for fitting a rotation to individual farm needs. Typical rotations showing high average acre yields in the tests at Huntley have been Rotation 4—corn, oats, spring wheat; Rotation 6—corn, barley, oats; Rotation 7—corn, oats, barley; Rotation 57—fallow, winter wheat, corn, barley; and Rotation 118—fallow, winter wheat, corn, oats.

Increased flax production has been urged by Administration officials to meet war-time requirements for vegetable oils. Experiments with flax have been under way at Huntley since 1912, and although the crop is better adapted to other parts of eastern Montana, a large amount of basic information has been obtained concerning production methods. Weeds are one of the most serious factors limiting flax returns, hence the crop should be sewn on the most weed-free seed bed obtainable. In the experimental rotations the best average yield of flax has been produced by growing the crop on spring-plowed corn land. The double weed control exercised through clean cultivation of the corn in the year preceding flax, followed by spring plowing to effectively bury surface weed seed, has contributed to the favorable result. Flax following clean cultivated corn, or clean fallow, has generally been superior to flax following flax, wheat, oats, or sod.

FORAGE AND PASTURE CROPS.—Increased livestock production to supply war-time meat demands would seem to call for an increased acreage in forage crops and cultivated pastures to supplement range grazing facilities as well as animal production on the dry farms. Tests at Huntley have shown that among the cured forage crops, the most productive and palatable have been Dakota

Amber sorgo, Sudan grass, corn stover, alfalfa and crested wheat-grass hay.

Crested wheatgrass has proved to be a valuable perennial grass pasture for horses, cattle and sheep, whereas alfalfa is a good legume pasture for hogs. Seeding experiments conducted with crested wheatgrass at Huntley, both on cultivated plots and on so called "abandoned" farm land, have indicated the value of late fall planting over spring planting in obtaining desirable stands. Pasturing dry-land alfalfa with hogs from early May to early July has shown that the crop can be successfully utilized in that manner even in seasons when it could not have been profitably cut for hay.

By the consecutive pasturing with hogs of such annual crops as winter rye, peas, soybeans, sudan grass, sorgo and corn, the Huntley experiments have shown that it has been possible to provide green and palatable grazing throughout the growing season from early May to September or later.

WAR-TIME APPLICATION OF RESEARCH IN THE DAIRY INDUSTRY HUNTLEY, MONTANA—1941-42

By

D. V. Kopland, Assistant Dairy Husbandman

The work of the Bureau of Dairy Industry at the Huntley Field Station during the calendar year of 1941 was largely a continuation of several long-time projects relative to the development of higher producing dairy cattle and the improvement in the quality of farm-grown roughages.

The breeding program, based upon the continuous use of proved sires in the station herd and also the herds of neighboring cooperators, has clearly demonstrated the practical application of the theory of the use of meritorious proved bloodlines. The advertising displayed by many commercial breeders of pure-bred dairy cattle calls attention to the fact that the theory is being put into practice to an increasing degree. Records kept at the station involving over 1000 cows in cooperators' herds, sired by sons of the station's proved sires, show that this system of breeding leads to about one failure in every six bulls used. This compares very favorably with the better known breeding systems heretofore used, since the best that could be expected from these systems of breeding has been a fifty-fifty chance of success. The results of 20 years' work along these lines are being tabulated for publication.

A recent bulletin entitled "Yield, Chemical Composition, and Feeding Value for Milk Production of Alfalfa Hay Cut at Three Stages of Maturity" concerns the harvesting of alfalfa at the

Huntley Station. This work clearly shows the value of cutting alfalfa on a immature basis for dairy cattle.

In this experiment alfalfa was cut at three distinct stages of maturity: initial bloom or when the flowers first began to appear; half bloom; and full bloom. Cutting alfalfa hay at the initial or half-bloom stages resulted in the greatest total yield tonnage, total digestible nutrients, and also the greatest economy of nutrient production. Likewise, previous experiments at this station have shown the desirability of harvesting or grazing pasture grasses at an immature stage.

Cost of production studies at the station show that nutrient production in the form of roughages is accomplished more economically than in the form of concentrates such as cereal grains. Since certain areas of the state are particularly adapted to the production of roughages, it is good management to harvest at the time of maturity roughages that will produce the greatest amount of total digestible nutrients. This can be accomplished, whether the crop is for hay, ensilage or grazing purposes, by harvesting either mechanically or by livestock at the proper stage of maturity.

During the 1941 season, grass crops grown on irrigated land at the station for ensilage purposes and harvested on an immature basis, produced green forage amounting to from 10 to 17 tons per acre when put into the silo. The crops consisted of a mixture of grasses and legumes. The green cut grasses and legumes were put into the silo after wilting to approximately 65 to 70 per cent moisture. No preservative was used at the time of ensiling and the resulting ensilage was of excellent quality. The ensilage was fed to dairy cattle during the less productive pasture months and helped greatly to maintain a steady flow of milk.

Several years ago this station conducted an experiment to determine the effect upon the production of milk cows when they were fed a full feed of roughages alone and when roughages were fed and supplemented with either a full feed of grain (1 pound of grain to 3 pounds of milk) or a limited feed of grain (1 pound of grain to 6 pounds of milk). The results of this experiment are of particular interest at this time and are summarized as follows:

Holstein cows capable of high production produced, on a mature age basis, an average of 13,656 pounds of milk during lactation periods of 365 days. This group of cows dropped healthy, normal calves and completed their lactation periods without a loss in body weight. The group fed a limited feed of grain in addition to roughage produced, on a mature basis, 16,848 pounds of milk or 22 per cent more milk than was produced by the roughage group. This group dropped healthy, normal calves and gained approxi-

mately 8 per cent in body weight. The full-fed group, on a mature basis, produced 17,851 pounds of milk or about 30 per cent more than was produced by the roughage group but only about 6 per cent more than was produced by the limited grain group. They likewise produced healthy, normal calves and increased their body weight by 15 per cent.

Taking into consideration the cost of feed at the time of this experiment, it was found that the feed cost of producing 100 pounds of milk varied greatly between the full-fed grain group and the roughage or limited-fed grain group. The full-fed group produced milk at a cost of \$0.75 per hundred pounds while the roughage group as well as the limited-fed group produced milk at a cost of only \$0.59 per 100 pounds.

From the standpoint of returns above feed cost, considering prices at the time of the experiment, it was found that the limited-fed grain group returned a gross sum above feed cost of \$99.96, the roughage-fed group returned \$80.81, and the full-fed grain group returned \$69.83. The important point to be considered at this time is that while the roughage group produced milk as efficiently as the limited-fed grain group, the latter group returned by far the greatest total sum above feed cost.

The bulk of the milk produced in the state is from dairy cows that would be classed as roughage-fed cows. Since it is necessary to increase the milk production of the state substantially, the results of this experiment show that much could be accomplished immediately by the increased feeding of grain and, when wisely done, would also result in a substantially increased income to the dairyman. This experiment is reported in detail in Montana Agricultural Experiment Station Bulletin 293.

JUDITH BASIN BRANCH STATION

By

Ralph M. Williams

The Judith Basin Branch Station is operated cooperatively by the Montana Experiment Station and the U. S. Department of Agriculture and conducts investigations in the production of dry-land field crops and feeds as well as the management of some livestock.

Results of the work at the station are directly applicable to those portions of the state and Northern Great Plains in which the annual precipitation borders on 14-15 inches.

The long-time experiments at this station have been carried on for thirty-three years regarding the dry-land rotation, tillage, and crop sequence studies and these results are used by farmers and technical workers in agriculture. Never has agriculture been more interested in cutting or lowering the cost of production than during

this present emergency.

Complete climatic records have been kept since 1909 and show the relationship of precipitation, evaporation, wind velocity, humidity, maximum, minimum and mean temperatures to various investigations under way.

The long-time yields of rotated crops clearly show the need for better utilization of the facts available in regard to tillage methods, rate, date and methods of seeding. Periodic failures due to deficient or poorly distributed annual rainfall emphasize that especially during the war emergency only those crops or varieties of grains, grasses or feeds should be grown which are well adapted to the area and possess some drought resistance.

Winter wheat is more dependable in average yield per acre than spring wheat at Moccasin, and on fallow produces 10-15 per cent higher returns than spring wheat.

Recent fertilizer tests using the lower rates of application are proving profitable for both winter and spring wheat. Further work is needed before definite recommendations are forthcoming. This work re-emphasizes the known phosphorus deficiency and lack of nitrogen on the shallow bench-type soils.

In rotations at Moccasin the best average yield of flax (about 9 bushels per acre) has been produced on spring-plowed corn ground.

Adequate feed production and feed reserves have always been of paramount importance to Montana livestock operators. In a war program that demands more livestock the production and utilization of forage and pasture grasses become vital to the nation. State and federal research organizations are attempting to find and develop grass species which are superior to our native types.

The work at the Judith Basin Branch Station regarding the rate, date and method of seeding crested wheatgrass on previously cropped land, restoration, or marginal land has received much publicity.

The pasture work as presented in Bulletin 388 "Dry-Land Pastures at the Judith Basin Branch Station", contains the following conclusions:

1. Chemical analyses indicate that crested wheatgrass is quite similar in composition to brome grass and a composite of native grass species during the summer grazing season.

2. Analyses of winter forage show that crested wheatgrass is lower than either the native or brome grasses in protein content.

3. Crested wheatgrass furnished grazing about two to three weeks earlier in the spring than either the native or brome grass pasture.

4. The average length of grazing season for the period 1934-1940 was 125, 93, and 113 days, respectively, on crested wheatgrass, native grass and brome grass.

5. Crested wheatgrass produced an average of 782 animal days of grazing on the 23.6 acres pasture as compared to 374 days on native grass and 509 days on brome grass.

6. Crested wheatgrass produced an average of 33.1 animal days of grazing per acre, as compared to 15.1 days on native grass and 21.5 days on brome grass.

7. The average daily gains per animal were about equal for the livestock on all three pastures.

8. With more favorable rainfall during the latter part of the experiment the results showed that to obtain maximum utilization of crested wheatgrass it was necessary to stock the pasture at the rate of one animal to two acres.

9. The average total gains in animal weight per acre were 70.2, 32.5 and 45.5 pounds respectively, on the crested wheatgrass, native grass and brome grass.

10. Brome grass has been intermediate in value when compared to the crested wheatgrass and native grass pastures.

Winter feeding trials show that various types of crested wheatgrass hay (both Standard and Fairway strains) when cut before bloom stage produce profitable gains when fed as a winter roughage to steer calves and especially when supplemented with a protein feed. In one trial where steer calves were fed crested wheatgrass hay (Fairway strain) cut before bloom stage, plus 3 pounds of cottonseed-molasses-beet pulp pellets, a gain of 1.52 pounds per head per day was recorded. Since these steers gained significantly more than the steers in the other three lots included in this second trial, it is concluded that this type of crested wheatgrass hay (Fairway strain) cut before bloom is superior as winter roughage.

Steer calves fed crested wheatgrass hay (Standard strain) cut before bloom stage, plus 0.9 pounds of soybean oil meal pellets per head per day make a gain of 1.30 pounds per head per day. Since these steers gained significantly more than the steers in the other three lots within the third trial, it is concluded that this type of crested wheatgrass hay (Standard strain) cut before bloom is superior as a winter roughage to the other types tested. In addition, these steers consumed 1.8 pounds more hay per head per day than the steers receiving native hay or crested wheatgrass hay (Standard strain) cut after bloom stage.

Winter pasture trials have shown the advisability of utilizing crested wheatgrass pasture in the fall or winter as long as there is some new growth available to supplement the coarse or wiry mature plant which is low in feed value.

The Moccasin Station has done considerable work regarding the dissemination of high quality seed of the recommended small grains and commercial crested wheatgrass. Three of the present four recommended winter wheats for Montana were selected from the cereal nurseries at Moccasin. Plant breeders and cereal

workers not only in Montana but in the United States consider Moccasin an ideal proving ground in testing varieties, selections and hybrids for resistance to drought and winter hardiness.

Recently Russian wild-rye (*Elymus junceus*) has been acclaimed as a new grass for the Northern Great Plains. Its possibilities and various characteristics have been observed at the Judith Basin Branch Station grass nursery at Moccasin since 1928.

Observations at this station indicate that Russian wild-rye is one of the few grass species which can invade a pure stand of crested wheatgrass under dry-land conditions. Present tests being conducted at this station should determine the recommended rate, date and method of seeding of this grass under central Montana conditions on fallow as well as on old established stands of crested wheatgrass.

Varietal studies with trees and shrubs show that the "Caragana or Siberian Pea-tree" is especially adapted to dry-land areas similar to central Montana. Its greatest use is in a hedge or for the outside rows of a windbreak. Other species of trees adapted to the local conditions are —coniferous: Colorado Blue Spruce, Black Hills Spruce and Western Yellow Pine, and deciduous: Green Ash, American and Chinese Elm. Field results show that about 75 per cent of the young coniferous stock when set out directly in the field are lost. When "canned" as seedlings and placed on the north or shady side of a building for a year to temper and develop their root system only 2 to 5 per cent were lost. To "can" a conifer, the young seedling upon arrival from the nursery is packed securely in a five-quart oil can with moist dirt. The can should be burned with gasoline or oil to remove the paint, thus allowing quick rusting, and the bottom of the can must be perforated to allow root growth and provide drainage. These "canned" trees are then placed close together and filled in and around with dirt to hold all moisture. During the dry periods of the summer they can be watered easily and, being in the shade, are soon tempered. The following year the young conifers can be set out (after the can is removed leaving the dirt firmly about the roots) with a much better chance of survival, because the year-old seedling is tempered and has its root system partially developed.

NORTH MONTANA BRANCH STATION

By

Fred S. Willson

AGRONOMY

The results of research at this station should prove to be a valuable guide for the dry-land farmers in Northern Montana for stepping up their efficiency and making adjustments to meet the

increased demands placed upon them because of the war.

Positive response in crop rotation has been observed only when fallow or corn have been included. Raising corn instead of fallowing, in order to have more feed for livestock, will sacrifice about 3.8 bushels of wheat, but gain over 2500 pounds of corn fodder in the 2-year period. The use of green manures and barnyard manure in rotations has always had a depressing effect upon yields of the following crop.

No substitute has been discovered for fallow to obtain maximum crop production on dry land. Yields of spring wheat and winter wheat were significantly higher with fallow than any other tillage method. The same is true for all small grains.

Corn grown continuously on the same ground offers one of the best possibilities for maximum feed production. For instance, corn on spring-plowed corn ground averaged 3277 pounds of fodder compared to 2557 pounds on spring-plowed grain stubble, or 4194 pounds on fallow. The early varieties such as Gehu and Burleigh County flints and Northwestern dent and Falconer semi-dent can be expected to return high yields of fodder and occasionally a good grain crop. In the corn breeding work there are a few hybrids and top crosses that look promising. However, a few more years of work will be needed before definite results can be determined.

In some instances, sorghum, a drought-resistant crop, has produced high yields of forage. This crop when properly handled is safe to feed. The cereal crops may be a source of forage for the dry-land farmer who is increasing his livestock production. Both winter and spring rye have produced high tonnages of hay. This forage, although less palatable than oat hay, has given very good results in wintering beef cows; in fact, it was just about on a par with blue joint or alfalfa. Oat hay has given the best results of any of the roughages in these tests.

Mustard seed tests were recently begun at this station, aimed at developing drought-resistant strains for use in the mustard seed-producing areas of Montana. This crop has taken on increased significance since imports have been cut off by the war. The same is true of all the oil-bearing crops. Flax and safflower have not been outstanding under our conditions. Yields have usually been low, with good yields the exception. Flax on fallow has proved the best combination. A good, clean, firm seed bed, planted to Bison flax around the first of May, is recommended.

New varieties, selections, hybrids or crosses of all the small grains are compared with established varieties. Yogo winter wheat has been outstanding for winter hardiness, smut resistance and yield. Thatcher, a highly rust-resistant spring wheat, has consistently outyielded other spring wheats here, although it has

averaged one pound per bushel less in test weight than Marquis or Ceres. There are new varieties of oats that look promising and may take the place of Markton or Gopher in this area. The same is true of barley, as some of the crosses tested here last year yielded 231 per cent of Horn. Time will tell whether or not any of these crosses are to be recommended.

Foundation seed stock of a large number of the recommended varieties of grains is grown here. This makes it possible for the members of the Montana Seed Growers Association to have available a dependable supply of absolutely pure seeds for them to increase.

Timeliness of operation is of great importance to successful dry-land farming. Date of seeding tests have shown that winter wheat seeded during the last half of September returned the highest yields. With respect to spring-sown grains, early seeding of rye, oats and barley are desirable. Spring wheat seeded about the 10th of April seems to give the best results. Corn has matured satisfactorily when sown about the middle of May.

Fall seedings of crested wheatgrass have pointed out an inexpensive and easy way of extending the range possibilities with respect to abandoned land. Stands are established almost without exception and the early spring grazing and late fall grazing fits admirably into proper range management, when the rancher has native range the balance of the year. Using the same methods it has been demonstrated here that it is possible to increase the carrying capacity of native range that has been impaired through prolonged drought or overgrazing. One hundred acres of poor native range land has been improved by this method at the station.

Thousands of acres of crested wheatgrass have been seeded in Montana and undoubtedly will be an important factor in helping Montana's ranchers and farmers meet the government's increased demands for marketing more livestock products.

Many other grasses are being studied in the grass-adaptation nurseries, with the hope of finding some new varieties or mixtures that might prove superior to the present ones. Some 200 acres of abandoned land was seeded to various grasses and mixtures. These can be grazed to determine palatability, relative carrying capacity, drought resistance under range conditions, and recovery from grazing.

Soil and moisture conservation have taken on increased importance. A new project was started in cooperation with the Soil Conservation Service to determine the best means of handling crop residue and to study the effect on soil and water conservation and crop yields.

The artificial erosion project on new land has shown the 6-inch removal plat to give the best yields during the past 2

years. Old land was put into this project last year. Here the check gave the best yields; the 6-inch removal next, and the 10-inch removal the poorest.

ANIMAL HUSBANDRY

Livestock research at the North Montana Branch Station has consisted principally of beef cattle investigations. A number of experiments have been conducted that will be of value in pointing the way towards achievement of beef production goals. Emphasis has been placed on increase in pounds of beef marketed rather than on increase in livestock numbers.

Studies with large and small type Herefords have shown that calves sired by large type bulls were significantly heavier than calves sired by small type bulls. Progeny of large type bulls were also significantly heavier in the fall as yearlings, 2-year-olds, and 3-year-olds. The difference in favor of the large type breeding for the three age groups was 52.0 pounds, 52.9 pounds and 43.9 pounds, respectively. The feed lot performance also shows some advantage of the steers sired by the large type bulls. When steers from the cow herd at Havre were fed out at Bozeman, the large type groups averaged slightly more profit to the feeder and weighed heavier both in and out of the feed lot.

The experimental work on wintering heifers on different planes of nutrition has shown that the effects on the progeny of heifers fed a low maintenance ration as calves, yearlings, and 2-year-olds were not permanent. Weaning weights of calves from full-fed, 3-year-old heifers were significantly heavier than from limited-fed, 3-year-old heifers. After this age there were no significant differences in weaning weights of calves from limited- and full-fed cows. However, there were substantial weight advantages in the fall in favor of the calves, yearlings and 2-year-olds given all the hay they would consume in the winter. These results indicate that for the producer who markets long yearlings or 2-year-olds, a good management practice would be to supplement the winter forage of the steer calves and yearlings as much as possible.

Additional research includes testing Hereford sires for the efficiency and rate of gain of their progeny. This experiment has been conducted in cooperation with the U. S. Range Livestock Experiment Station at Miles City.

Range management studies are in progress on the summer range. Methods of securing a more uniform distribution of livestock by fencing, development of springs, and salting, have been tried with good results. Carrying capacity determinations that are under way are of particular value to stockmen in this area.

UNITED STATES RANGE LIVESTOCK EXPERIMENT STATION

By

J. R. Quesenberry

The U. S. Range Livestock Experiment Station has continued to conduct research in animal breeding, nutrition and management as in previous years. These problems have been brought into unusual prominence because of the augmented production of livestock products made necessary by the National Defense Program and the foreign food situation.

Food is Number One ammunition not only for ourselves but for our allies with their vast battle line across the world. In the production of that food we need to exercise wisdom. For the most part, increased production should come from better breeding, feeding and management practices rather than from increased numbers. We should hesitate before increasing numbers of inefficient low quality breeding animals.

Due to the greater and more numerous problems and because beef cattle have a greater economic importance in this region than any other meat animals our research program on beef cattle improvement has first attention.

The first step in this program is an effort to produce true breeding strains which possess such characteristics as fertility, economy of gain and quality of product. Along with improvement in breeding goes, of course, the investigation of better management and feeding practices, which includes the management and development of pastures.

The Record of Performance tests which have been carried on to measure the worth of the various sires are an important phase of the breeding program. The purpose of the Record of Performance investigations is to test the breeding characteristics of the sires on the basis of merit of their progeny for producing superior beef. This characteristic is measured by the ability of the offspring to produce rapid and efficient gains and carcasses that meet the market demands.

A statistical study of the data accumulated during the last 5 years on Record of Performance of 127 steers, 98 of which were sired by three bulls and 29 by four other bulls, indicates that inherited differences between the progeny of various sires may be determined from such production factors as weaning weight, daily gain in the feed lot, efficiency of gain in the feed lot, and dressing percentage of the offspring. The study also indicated that efficiency of gain or rate of gain in the feed lot during fattening can not accurately be predicted from rate of gain during the suckling period or from scores at weaning time.

Studies on the effect of age of cow on weight of calves at

weaning time under range conditions indicated that 9-year-old cows produce about the same weight calves at weaning as 3-year-old cows, but owing to smaller calf crops and greater winter death losses it is desirable to dispose of breeding cows after they reach that age. Greater gains to weaning time were made by calves from 6-year-old cows than by those of any other age.

In an effort to pave the way to greater profit and economy in beef production the U. S. Range Livestock Experiment Station in cooperation with the Forest Service has continued grazing experiments to determine the effect of three intensities of grazing. The density of vegetation on all pastures increased over the previous year. At weaning time calves from the cows on heavily grazed ranges, stocked at the rate of 23.1 acres per cow, based on year-long use, averaged 407.5 pounds in weight; those from moderately grazed ranges, stocked at the rate of 30.5 acres per cow, averaged 453.9 pounds; and those on lightly grazed ranges, stocked at the rate of 38.8 acres per cow, averaged 461.6 pounds. The cows on the moderately and lightly grazed ranges produced calves that were significantly heavier at weaning time than those produced on the overgrazed range. Cows in the overgrazed group required 1213 pounds of hay per head, those in the moderately grazed group 106.5 pounds, while those cows in the lightly grazed group did not require any hay. Since this experiment has been underway results show that the herd grazed more conservatively produces more calves, the calves being heavier at weaning time and more profitable. The cost of range forage and supplemental feed required to produce a pound of calf to weaning age under heavy stocking was much greater than under conservative grazing.

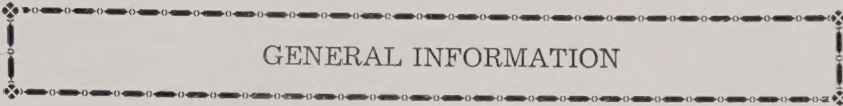
The study of the incidence of bloat was continued with steer calves fed three different combinations of feed available in the region. In a 265-day trial, steer calves fed an average ration of 10.3 pounds of a grain mixture containing $4\frac{1}{2}$ parts of barley, $4\frac{1}{2}$ parts dried molasses beet pulp, 1 part linseed oil meal and 3.5 pounds alfalfa hay gained 479 pounds a head, and only one mild case of bloat occurred at the beginning of the period. Similar lots of calves fed an average ration of 10.3 pounds of a mixture composed of 9 parts barley, 1 part linseed oil meal, and 3.5 pounds of alfalfa hay gained 446.3 pounds per head, and four steers were severely bloated and scoured at different periods during the trial. The calves in these two lots were fed the same amount of concentrates and roughage. A third lot of similar steer calves full-fed on the barley, dried molasses beet pulp mixture, 12.02 pounds daily per steer, and 3.4 pounds of alfalfa hay gained 517.2 pounds and had no off-feed difficulties and no serious bloat. All three lots had access to the same mineral mixture of equal parts of salt and bone meal.

In this trial replacing one-half the barley by an equal amount of dried molasses beet pulp and feeding at the same level resulted in slightly larger and more economical gains and reduced the incidence of bloat. Full feeding of the ration in which dried molasses beet pulp replaced one-half the barley not only reduced the feed lot disorders but it increased the gains; reduced feed required per 100 pounds gain; increased the finish and made a greater financial profit.

Grazing studies with sheep which have been conducted in cooperation with the Forest Service since 1936 were continued during the year. During the past 4 years, yearling ewes gained 5.7 and 9.9 per cent more on moderately and lightly grazed pastures, respectively, than on heavily grazed pastures. The additional gains, at 8 cents per pound, would aggregate approximately \$150.00 and \$260.00, respectively, per band of 1200 ewes and represent an advantage in favor of conservative grazing. The average condition of the forage on the moderately and lightly grazed pastures was better than the average for the heavily grazed pastures.

In 1935 the U. S. Department of Agriculture instituted a worldwide search for breeding animals with outstanding qualities of excellence. Among other accomplishments this activity resulted in the importation of a sizable herd of Landrace hogs from Denmark and the establishment of a Landrace herd at the U. S. Range Livestock Experiment Station at Miles City. While this breed has shown a marked efficiency in producing the type of carcass especially suited for the foreign market, under American conditions the breed showed some serious faults.

Investigations at this station are chiefly concerned with a study of genetics, economy of pork production and quality of carcasses of crosses and various back crosses of the Landrace and Hampshire breeds in comparison with the parent breeds. This study has been in progress since 1936, and while initial progress has been slow, due to small numbers and rigid culling, at the present time there are indications that an improved strain may soon be an accomplishment. Probably the greatest benefit to be derived from this work will come with the post war adjustment. As the foreign countries again become selective purchasers of breeding animals and pork products they will be keenly appreciative of swine of the type being developed.



GENERAL INFORMATION

COOPERATIVE RELATIONSHIPS

Through another biennium, the Montana Agricultural Experiment Station has enjoyed and benefited from effective cooperation with a large number of Federal, State, and other agencies concerned both directly or indirectly with fact gathering to assist in the solution of some of agriculture's most pressing problems. Without the contributions from cooperating agencies, in the way of financial aid and technical assistance, the activities of this Station would be materially reduced.

Federal Agencies.—Among the Federal agencies with which this Station has enjoyed either formal or informal cooperation are the United States Department of Agriculture, the United States Department of the Interior, Tennessee Valley Authority, Work Projects Administration, National Youth Administration, National Resources Committee. Special mention should be made of the assistance received from the following Divisions and Bureaus of the United States Department of Agriculture: Agricultural Adjustment Administration, Agricultural Marketing Service, Farm Credit Administration, Farm Security Administration, Forest Service, Soil Conservation Service, and the Bureaus of Agricultural Economics, Animal Industry, Dairy Industry, Entomology and Plant Quarantine, Home Economics, Plant Industry, and the Rural Electrification Administration.

State Agencies.—In addition to friendly relations maintained with Agricultural Experiment Stations in nearby states and provinces of Canada, this Station has cooperated with certain State departments, including especially the Montana Livestock Sanitary Board, the Montana State Department of Agriculture, Labor and Industry, and the Montana Water Conservation Board.

Other Agencies.—Numerous commodity agencies have been most helpful in assisting the Agricultural Experiment Station with its research program, including especially, the Montana Stock Growers' Association, the Montana Wool Growers' Association, the Montana Seed Growers' Association, the Montana Potato Growers' Association, the Montana Horticultural Society, the Montana Florists' Association and the Montana Dairymen's Association.

In addition, the Anaconda Sales Company has rendered material assistance with a project to determine the extent of phosphorus-deficient soils and the types of phosphorus fertilizers best suited to such soils.

CHANGES IN STATION STAFF

Resignations.—During the period November 30, 1938 to June 30, 1942, eleven resignations have been recorded: Stephen Enke, and Dr. Benjamin H. Hibbard, from the Department of Agricultural Economics; Dr. A. M. Schleuber, from the Department of Agronomy; T. D. Watkins, Jr.,* J. N. Cummings, and Dr. O. S. Walsh, from the Department of Animal Industry; D. R. McCormick, from the Department of Chemistry Research; Dr. H. C. Kelly and Maxwell R. Sargent,* from the Department of Horticulture, Margaret Ekeberg and Alice Vandenhook as Bulletin Editors.

Dr. Vincent E. Iverson was granted leave of absence for military service for the duration of the war.

New Appointments.—To fill vacancies caused by resignations, the following appointments were made between November 30, 1938, and June 30, 1942: Stephen Enke, as Assistant Professor in Agricultural Economics; Dr. Benjamin H. Hibbard, as Visiting Professor in Agricultural Economics; Dr. Royse P. Murphy, as Associate Professor in Agronomy; T. D. Watkins, Jr.* and A. C. Kegel* as Instructors in Animal Industry; Dr. Oliver S. Walsh as Assistant Professor in Animal Industry; Ellsworth B. Hastings, as Instructor in Entomology; Alice Vandenhook as Bulletin Editor.

*Now in the armed forces of the United States.

FINANCIAL SUMMARIES

EXPENDITURES OF THE MONTANA AGRICULTURAL EXPERIMENT STATION
FOR THE FISCAL YEAR ENDING JUNE 30, 1941

	Hatch	Adams	Purnell	Bankhead- Jones	State and Others*
Salaries	\$ 7,744.02	\$13,261.47	\$45,395.54	\$11,274.34	\$55,914.17
Labor	4,680.37	391.92	7,818.26	3,044.39	21,555.95
Stationery and Office Supplies	531.19	—	—	—	3,156.60
Scientific, Consumable	70.60	595.58	1,171.54	259.80	3,549.65
Feeding Stuffs	21.45	—	346.20	320.59	10,195.56
Fertilizers	—	—	—	95.22	251.99
Sundry Supplies	20.18	—	—	—	2,303.78
Communication Service	472.23	5.15	28.44	—	1,662.15
Travel Expenses	325.61	630.75	1,472.57	69.82	3,620.97
Transportation of Things	13.15	3.67	20.52	1.19	609.06
Publications	562.03	—	1,042.70	—	1,999.06
Heat, Light, Water, Power	134.29	—	104.90	25.04	7,203.92
Contingent Expenses	—	—	16.09	3.09	705.14
Passenger-carrying Vehicles	11.05	—	6.31	—	1,006.97
Furniture, Furnishings, Fixtures	32.73	—	234.32	—	796.01
Library	205.15	4.08	37.88	—	722.69
Scientific Equipment	26.38	83.66	701.40	75.50	564.96
Tools, Machinery, Appliances	116.88	23.72	143.87	298.54	4,754.55
Livestock	—	—	556.57	—	3,530.39
Land Rentals	—	—	741.20	—	5,191.88
Buildings	32.69	—	161.69	35.64	3,283.43
Totals	\$15,000.00	\$15,000.00	\$60,000.00	\$15,503.16	\$132,578.88

*This fund includes the following:

State Appropriation for Home Station	\$44,301.42
For Grain Laboratory and Branch Stations	29,000.00
Income from Sales	56,512.07

EXPENDITURES OF THE MONTANA AGRICULTURAL EXPERIMENT STATION
FOR THE FISCAL YEAR ENDING JUNE 30, 1942

	Hatch	Adams	Purnell	Bankhead- Jones	State and Others*
Salaries	\$ 7,859.75	\$13,486.43	\$45,843.71	\$ 9,167.60	\$57,406.74
Labor	3,719.64	166.55	8,177.26	5,317.75	34,113.45
Stationery and Office Supplies	296.40	—	—	—	2,626.52
Scientific, Consumable	227.01	313.27	926.10	407.19	3,353.41
Feeding Stuffs	500.00	—	1,484.96	47.73	16,012.86
Fertilizers	—	6.75	—	76.75	597.98
Sundry Supplies	—	—	—	—	4,963.30
Communication Service	307.47	2.70	10.94	—	1,126.16
Travel Expenses	304.05	828.34	1,009.31	28.25	2,939.33
Transportation of Things	30.93	5.09	8.66	—	884.61
Publications	511.95	—	254.66	—	2,695.88
Heat, Light, Water, Power	683.11	—	38.94	—	4,093.06
Contingent Expenses	—	—	5.48	2.22	390.17
Passenger-carrying Vehicles	60.88	—	191.01	—	1,342.81
Furniture, Furnishings, Fixtures	28.18	—	86.90	—	661.84
Library	34.35	—	12.00	—	646.52
Scientific Equipment	20.70	184.42	455.95	363.86	426.63
Tools, Machinery, Appliances	255.71	6.45	898.41	57.94	12,263.06
Livestock	—	—	—	—	3,820.11
Land Rental	—	—	—	—	5,978.18
Buildings	159.87	—	595.71	33.28	2,409.69
Totals	\$15,000.00	\$15,000.00	\$60,000.00	\$15,503.16	\$158,752.31

*This fund includes the following:

State Appropriation for Home Station	\$59,100.00
For Grain Laboratory and Branch Stations	37,350.00
Income from Sales	78,570.45

ORGANIZATION OF THE AGRICULTURAL EXPERIMENT STATION¹

A. L. STRAND, Ph. D.—President

CLYDE McKEE, M. S.—Director

R. T. CLARK, Ph. D.—Assistant Director

F. B. LINFIELD, B.S.A.—Director Emeritus

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J. J. LIVERS, M. S., Asst. Prof.
H. H. LORD, M. S., Asst. Prof.
H. H. PLAMBECK, Ph. D., Instructor

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G. C. HUGHES, B. S., Instructor
A. C. KEGEL, B. S., Instructor

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EDMUND BURKE, B. S., Consult. Chem.
W. E. CARLSON, Ph. D., Asst. Prof.
GESTUR JOHNSON, M. S., Instructor

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D. P. PLETSCH, M. S., Asst. Prof.
F. A. MORTON², B. S., Asst. Prof.
H. J. SHIPMAN², M. S., Asst. Prof.
E. J. HINMAN², B. S., Asst. Prof.
E. B. HASTINGS, M. S., Instructor
R. C. NEWTON², M. S., Instructor

GRAIN LABORATORY

A. H. POST, M. S., Director
W. O. WHITCOMB, M. S., Supt.

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HELEN L. MAYFIELD, M. S., Asst. Prof.

HORTICULTURE

F. M. HARRINGTON, M. S., Prof. & Head
M. R. SARGENT, B. S., Asst. Prof.

RURAL ENGINEERING

O. W. MONSON, M. S., Prof. and Head

VETERINARY RESEARCH

HADLEIGH MARSH, B. S., D. V. M., Prof. and Head
HOWARD WELCH, B. S., D. V. M., Prof.
E. A. TUNNICLIFF, M. S., D. V. M., Assoc. Prof.

LIBRARY-PUBLICATIONS

F. B. LINFIELD, B. S. A., Prof. and Head
LOUIS G. TRUE, B. S., Agr'l. Publicity

MISCELLANEOUS

EVA DEAN ROBINSON³, Sec'y to Director
BERNARD COPPING, B. S., Asst. Secretary-Treasurer

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Horticulture Branch Station	Corvallis
W. E. POLLINGER, Superintendent	
WILLIAM R. FORSYTH, B. S., Assistant in Entomology	
Huntley Branch Station ²	Huntley
DAN HANSEN, Superintendent	
A. E. SEAMANS, B. S., Dry Farming	D. V. KOPLAND, B. S., Dairying
Judith Basin Branch Station ²	Moccasin
R. M. WILLIAMS, B. S., Superintendent	
North Montana Branch Station ²	Havre
F. S. WILLSON, M. S., Superintendent	
J. J. STURM	R. R. WOODWARD, B. S.
Assistant in Agronomy	Assistant in Animal Industry
U. S. Range Livestock Experiment Station ²	Miles City
J. R. QUESENBERRY, M. S., Superintendent	
A. L. BAKER, B. S., Cattle	R. E. Hutton, B. S., Swine

¹Organization as of June 30, 1942

²Cooperating with the United States Department of Agriculture

³Appointed September 1, 1942